THE

# POPULAR SCIENCE MONTHLY.

APRIL, 1883.

## NATURE AND LIMITS OF THE SCIENCE OF POLITICS.

By Professor SHELDON AMOS, LL. D.

THE progress of the strictly physical sciences in modern times has had a twofold influence on the advancement of those branches of knowledge which deal less with physical than with moral, social, and political facts. On the one hand, the exact methods and indisputable conclusions of the sciences concerned with matter have inaugurated modes of study and inquiry which are believed to be of universal application. On the other hand, the standard of rigorous logic in all studies is so far exalted that those subjects of thought or investigation which do not conform to identically the same standard as that maintained for the study of matter are thought to be not worth pursuing with any regard to the claims of a severe logical process. This sort of antipathy between the physical and the ethical regions of search and argument has been intensified by the co-existence of two opposed orders of minds, the ardently speculative and the persistently practical. The former are discontented with the notion of a so-called Science of Politics, because of the complexity of the subject-matter, and the intrusion, at all points, of such seemingly incalculable factors as the will and passions of mankind. Practical statesmen, again, immersed in actual business, and oppressed by the ever-recurring presence of new emergencies, almost resent the notion of applying the comprehensive principles of science, and still more the conjectural use of foresight, in respect of subjects which, for them, are in ceaseless flux, and can, at best, only be safely and wisely handled by momentarily adjusted contrivances.

Between these two extreme classes lies all the large portion of society composed of persons with minds less distinctly determined and

trained in one direction or the other, and therefore all the more open to be impressed by influences derived from sound thinkers and energetic workers, but experiencing these influences only in a loose and diluted form. The aggregate result is that the subject of Politics floats in the public mind either as a mere field for ingenious chicane or as a boundless waste for the evolutions of scholastic phantasy. If Politics are to be vindicated from the aspersions cast upon them from the opposite quarters here indicated, and are ever to be erected into a science, with its own appropriate methods and limitations, the foundation of these skeptical suspicions must be investigated and their real value strictly assessed. The investigation will proceed as follows:

1. One obvious class of objections to the possibility of applying rigorous scientific methods to Politics is founded on the number and nature of the component and preparatory studies which are presupposed in all strict inquiries into the theory of government. Assuming that the physical sciences—beginning (say) with astronomy and ending with physiology or psychology—have reached a strictly scientific stage, there yet remain, as properly leading the way to the study of Politics, all those branches of knowledge which depend on the composite nature of man both as isolated and as in society. Such are Ethics in the Aristotelian sense, comprehending as topics decorum and propriety as well as duty; political economy, which deals with the conditions under which national wealth is produced, accumulated, and distributed; law and legislation (sometimes comprised under the general head of jurisprudence), which deal with the essential nature, logical distribution, and historical growth of the general rules of conduct which all governments maintain and enforce; and, lastly, the somewhat novel science of Sociology, which deals with the inherent problems to which the aggregation of mankind into groups gives rise, so far as these problems can be abstracted and treated independently of government.

This list of studies, which might be multiplied and varied to any extent according to individual proclivities, incloses large areas of knowledge over the subjects of which the human will and human passions must have, at least in the course of ages, and in passing from country to country, an amount of influence which seems to set scientific precision at defiance. Nevertheless, and in spite of all the controversies waged among those who prosecute these studies, there is no doubt that in all these pursuits the most searching and exact methods, so far as they are applicable, are beginning to be used, and the certainty and universality of the sequence of cause and effect—that is, of laws of Nature—to be recognized as a premise.

The extension of the like severity of process to political studies is mainly delayed by the constantly disappointing incompleteness of the constituent and preparatory studies just enumerated. A Science of Politics, indeed, has its own special sources of embarrassment, owing,

among other things, to the necessity of co-ordinating in one view all the conclusions deducible from those other, and as it were introductory, researches. Of course, this process of combination abounds with its own manifold opportunities of error; but this fact need no more produce despair than the composite quality of physiology leads the student to be skeptical of the scientific character of inquiries into the constitution of the animal world.

There is a vast difference between calling a branch of knowledge a science, because it can only be profitably studied by the use of the same logical methods as are indispensable in the mastery of the best-established physical sciences, and being, as yet, scientifically cultivated, or advanced in outward form to the full proportions of a maturely developed science. It may be, indeed, that, from a number of causes to be shortly adverted to, Politics will always present an appearance neither homogeneous nor, in one sense, exact. But these defects neither impair the genuine truth of the universal laws to which the topic is submitted, nor ought to convey any imputation on the only methods serviceable in treating it.

Admitting, as a provisional and practical postulate, the freedom of the human will, it might indeed seem to be impossible, on the face of it, to bring within the domain of stringent scientific methods any class of materials largely conversant with the direct actions and emotions of mankind. But there are certain corrections which reduce the significance of any skeptical conclusions which might be drawn.

In the first place, the more extensively and minutely historical studies are carried on and the investigations of travelers pursued and recorded, the more uniform does human nature appear, and the more calculable are the actions, sentiments, and emotions of large classes of mankind, when the antecedents and surrounding conditions are ascertained. So far as political inquiries are concerned, it is more with classes, groups, and assemblages of men, and with considerable stretches of time, than with any individual men at a given moment that the investigator is occupied. Thus the historical method, in proportion as it is extensively pursued, contains in itself its own correctives.

But, in the second place, if the researches of historians and the reports of travelers contain an endless and boundless mass of facts which seem rather to increase the list of human eccentricities than to reduce it by discovering a dominant order and an integral unit of progress and purpose, yet here again the problem of finding a scientific form for the theory of government is on the whole simplified rather than otherwise. As explorations of all sorts are multiplied and extend, they take the place of the logical instrument of experiment; and the result of them is, that a limited number of propositions are evolved which admit of being announced with a fair assurance of their universality. If the area of observation be limited, the truths reached will,

indeed, be proportionately restricted in number, but within this area they will be none the less valid.

Thus, in the science of political economy, it is not universally true that, in all conditions of society, population tends to increase out of proportion to the means of subsistence; for the effective desire of individual self-enrichment constitutes in certain conditions a reparative and compensating force. So in law, it is not everywhere true that a human being is, in a legal sense, a person and not a thing; or that laws proceed from a consciously acting political authority; or that it is recognized as an axiom that taxation and representation go together. The several propositions here chosen, by way of illustration, from two of the component sciences which, with others, go to constitute the complete range of political studies, and help to convert those studies into a separate science, are only partially and relatively true at certain places and periods. But, within these limits of time and place, their truth, and the truth of all like propositions, is invariable and incontestable.

Thus, if the composite nature of Politics impairs the universality of the majority of the propositions with which it is concerned, this only establishes the relativity of these studies, and in no wise detracts from their usefulness or supersedes the employment of those rigorous logical methods which in other respects continue to be applicable.

2. Another reason which accounts for the unscientific aspect under which political studies usually present themselves is that it very rarely happens, or has happened, that conscious attention to the true character of governmental problems, to their difficulties, and to the modes of their solution, is aroused in any nation till long after a practical solution of some kind has been instinctively resorted to, and a considerable advance in the art of administration achieved.

An exception might be supposed to exist in the case of colonies and dependencies, at the first foundation of which all the materials seem to be within the conscious control of the parent or governing State. But it is just on this very account that theoretical truths have here their most hopeful platform, and are habitually applied in practice to an extent which, because of unnoticed but vitiating errors of calculation, is often fraught with serious hazard. The Cornwallis settlement in Bengal, the early land policy of the Australian colonies, and the attempted central taxation of the American colonies by the British Parliament, are all instances of the over-hasty application, to materials believed to be malleable, of firmly fixed political principles. The principles themselves, indeed, in all these cases, needed re-examination and restatement.

The obstacles to at once applying even the best-established principles of government, in all conceivable emergencies, so soon as conscious attention happens to be awakened to the national needs, are sufficiently obvious. It is not only that the principles themselves

usually demand modification in view of the circumstances of the people and of the day, but that the greatest allowance must always be made in all political reforms for the influence of fixed sentiments and habits. It also may happen that bad institutions—such as a bad poor-law system, or, in the criminal law, a falsely-conceived relationship between crimes and punishments—may have generated a vast and complex web of affiliated ideas, customs, institutions, and laws, which can severally be neither defended in principle nor yet rudely disdained and cast aside.

For not only do custom and habit enable a people, or classes of a people, to work in long-established grooves with the smallest amount of friction and obstruction, but the mere fact of the long existence of a familiar usage so far fashions in its own image the mind and even the conscience of a people that a critical reformer has a hard and unpopular task to perform in assaulting even the most indefensible abuses. The large mass of the people, if disused to political change of any but the most cautious, slow, and tentative kind, have their sentiments of loyalty and reverence outraged by the sudden introduction of what is new and unfamiliar. Their mind has been trained and pruned in such a way as to be unable to conceive, as a mere intellectual notion, a better ordered world than that in which they live. Where too great a disparity, both in sentiments and in intellect, exists between the reformer and the people, or even between different classes of the people in the same community, it may show that the times are not yet ripe for changes recommended by deference to the claims of logic and of justice.

Instances in point are supplied by the difficulties experienced by the British Indian Government in dealing with such patently immoral institutions as polygamy ; by the attachment of the Scotch to a law of marriage which notoriously facilitates the most cruel of frauds ; and by the obstacles in all countries to any comprehensive reconstruction of the systems of land-tenure and inheritance, and of civil, and still more of criminal, procedure. These last-mentioned institutions have seldom been radically altered in any country by any process short of revolution, however persuasive the voice of right, of reason, and of utility, in favor of change. So vast is the number of individual persons interested in these classes of matters, so well habituated are they, and consequently so deeply attached, to the recognized forms, usages, or even gestures, customarily in use—many of which are of a public nature and are daily witnessed by all men—that any vital reconstruction seems little short of sacrilege, and the most conclusive reasons in favor of it are scarcely comprehensible.

3. It is needless to point out that the conception of Politics as a Science is much affected by the imperfections of Politics as a practical Art. It is not only by reason of the existence of ineradicable institutions and ideas that the scientific development of political studies is

hampered and delayed. There is another reason of a still more commanding importance which operates in the same direction with a still more signal force. It is that, at any given moment, when the legislator, or administrator, would otherwise most desire to govern with due regard to well-established principles dictated by abstract political science, he is imperatively urged on to the front, and impelled into action, by the pressing necessity of instantly choosing between a limited number of possible alternative courses. Most of all is this the case in what are sometimes called constitutionally-governed countries — that is, countries in which representative institutions have reached a tolerable degree of advancement, and political knowledge and interest are widely diffused. In these circumstances a spontaneous organization of political leaders and their respective followers into parties for the purpose of uniform and combined action is sure to have taken place.

The result is, that an artificial effort will be made, at each critical occurrence which seems to call for the intervention of the Government, to narrow the possible courses of action to a very few immediately intelligible expedients, recommended rather by their rough conformity to some pre-existing schemes or ideals in favor with the different contending parties than by their intrinsic harmony with scientific requirements. No doubt the party leader who is himself imbued with a scientific spirit, and is personally disposed to do as little violence as possible to his cultured instincts, will do his utmost to bring all his measures into the shape which his logical and historical training, applied to all the circumstances of the special case, leads him to desire. But action at once and without further delay is unavoidable. A decision can only be deferred at the cost either of letting go the opportunity for providing a remedy of some sort for a possibly crying abuse ; or of openly confessing impotency ; or of surrendering to others a leadership which, with all its demerits, is probably believed to be, on the whole, fraught with good rather than with evil. Thus the peremptoriness of political opportunities and the necessity of instant action withstand, in a country with free representative institutions, every effort to impart to political action through a long period a comprehensive, consistent, and scientific character.

It is no wonder if the same class of facts reacts on the intellectual conception of the position of Politics as a subject of study and of knowledge.

The topic is naturally relegated to the region of caprice and accident, or to that of tentative experiment and spasmodic contrivance. This intellectual consequence is intensified by the fact that all Governments—and not least those known at the present day as the freest and, on the whole, the soundest—are habitually made the arena of purely ambitious contention, of selfish aspiration, and even of corrupt conspiracies against the public well-being. The wider the territorial area

of any particular Government, and the more complicated and extensive its essential mechanism, the more opportunity there is for the exhibition of personal or, at the most, of local self-seeking. So far as this prevails, Politics becomes degraded into a mere vulgar struggle for money, office, or power. All actual reference to scientific considerations is excluded. The tone of public thought and sentiment becomes proportionately infected, and all the claims which might otherwise be asserted on behalf of Politics to take its place by the side of other sciences dealing with such moral elements as the human Will meet with a skeptical repudiation.

Where free representative institutions are not found, and absolutism of one type or another prevails, the way is more open for a deliberate choice of the policy to be pursued in any sudden emergency. Such a case has presented itself, again and again, on the occurrence of famines in British India. Could such a casualty occur without being long foreseen in a country enjoying a popular constitution, the question of remedies would be instantly debated in every kind of public assembly, and by all the organs of public opinion, with a ferment of party zeal which would daily gain in heat and vehemence, and would impel statesmen to select with over-much precipitation between the limited number of remedial measures which enjoyed, for one cause or another, the popular favor.

The legislation demanded in the case of a failure of the potato-crop in Ireland has more than once illustrated this position. One party advocates the institution of public works, of a purely wasteful or superfluous kind, on an enormous scale; another is in favor of indiscriminate out-door relief; a third recommends, with the late Lord George Bentinck, the construction at the public cost of railways, with the purpose at once of employing labor on a large scale and of distributing food. However much a judicious statesman may be opposed to all these views, yet for fear of being reduced to nullity, and of having to give place to opponents, he can only connect his own name with, and invite the adhesion of his followers to, what seems on the whole the least objectionable of the popular alternatives. The utmost he can do is to combine different courses in such a way as that some special evil of one may neutralize some greater evil of another, and to introduce modifications which may escape general attention, but which none the less go some way, at least, to qualify the mischievous operation of the scheme, a professed adoption of which can not be evaded.

It will depend, of course, very largely on the constitutional circumstances of the country how far, even in the case of a pressing emergency, the art of Politics may be made to comply with the requirements of scientifically ascertained laws. Where a large and promiscuous population has to be satisfied or must be appealed to by statesmen for political support, the measures must be instantly intelli-

gible and not too far removed in their conception from the average ken of mankind as represented then and there. The ulterior objects proposed must not belong to a too distant future: the pursuit of them must not involve what seem to most people excessive or disproportionate sacrifices: they must easily and obviously connect themselves with the common wants and feelings of the many at the moment, rather than with the (seemingly) problematical aspirations of a few in the indefinite future.

The case is different where popular government has not yet established itself, and where, in consequence, none of the above obstacles, even at a critical juncture calling for the immediate intervention of the legislator or administrator, are presented. But the exemption of the statesman or ruler from the checks of popular control of a constitutional kind by no means insures a deference to purely scientific demands. Timidity, rashness, prejudice, personal rivalries, and the still less worthy influences of calculating self-interest or of a narrow ambition, dwarf and vitiate a policy not less surely than do the impediments due to popular ignorance and incompetence. The statesman, in the one case as in the other, is bound to act—and this too without delay; and, though a scientific resolution can not be excluded, yet, from one cause or another, the temptations to deviate to this or that side are numerous and urgent. There have indeed been statesmen who have so far impressed their own personality on their policy, and communicated their views and aspirations to the bulk of the governing population that, at special exigencies, the public confidence previously won has enabled them to dictate a course scarcely comprehended by the people at large. Such a position was occupied on certain occasions by Count Cavour in Italy, Presidents Lincoln and Grant in the United States, even to some extent by Prince Bismarck in Germany, to a still greater extent by M. Thiers in France, conspicuously by the Duke of Marlborough for a time in England, and in modern times by Sir R. Peel, Lord Palmerston, and Mr. Gladstone.

So also in Governments not controlled by representative institutions—such as those of almost all the States of Europe except England, up to very recent days—there have always been found exceptional rulers who, in spite of all temptations to indulge selfish prepossessions in favor of ease or aggrandizement, have availed themselves of the peculiar felicity of their situation to pursue a consistent and far-sighted policy, undisturbed by all casual occurrences or misadventures. To this class have belonged many well-known administrators of British India and of the Crown Colonies of Great Britain, as well as certain absolute sovereigns in ancient and modern times.

It appears, then, that not only does the imminent necessity for immediate action present serious obstacles to the pursuit of a policy founded on the teachings of critical observation and a wide-reaching

experience—that is, on science—but the mere fact that statesmen are constantly impelled to act at once in directions which very imperfectly correspond to their own conceptions of what is really best throws a shadow of doubt and uncertainty over the scientific character of the studies concerned. It is felt, not unreasonably, that if those who are most concerned to be acquainted with the best methods of political research forbear to turn these methods to account at the moment of the utmost need, this is at least as likely to result from the inherently imperfect and illogical nature of the branch of knowledge in question as from any other cause. To this comprehensive skepticism some of the classes of facts above adverted to may be held to supply an answer. The unscientific character of a policy adopted at any crisis has often been an exact measure of the amount of external pressure applied through the competition of factions, or through the impetuosity of a populace only jaded into an unwonted attention to political affairs by exceptional events. Where this pressure is not at hand, rulers still may, indeed, through unworthy influences and motives, prefer the worse to the better way; but enough instances of the persistent maintenance of a deliberately adopted policy in the face of the most seductive allurements to fluctuation have been exhibited to show that it can not be fairly alleged that Politics must necessarily be unscientific because few in the real business of life have time, or liberty, or tenacity of purpose, sufficient to withstand the impetuous torrent of popular zeal generated by sudden crises or catastrophes.

Probably the most real and enduring objection to the claims of Politics to assume the rank of a true science is the confessedly immature and imperfectly developed character of the component or preparatory studies, apart from which, in their combination with each other, the study of Politics can not be pursued. It has already been noticed that the complex and composite nature of political studies is of itself a presumption against the facility, if not against the possibility, of ever imparting to those studies the rigorous certainty essential to Science. But this presumption is greatly increased by the fact that in such broad but indispensable preparatory studies—confessedly of a scientific aspect—as Ethics, Economics, and Jurisprudence, there are to be found only the very smallest number of uncontroverted propositions. And, even as to the logical methods applicable in each branch of knowledge, no generally assented-to decisions have yet been accepted.

There is thus afforded to the skeptically-minded a wide opening for treating as unscientific a study which, like that of Politics, must be built up on conclusions yet to be established in those other regions of knowledge, but none of which are as yet established with a certainty which is beyond debate. Nevertheless, if it be admitted that those component studies are capable of being placed on a strictly scientific foundation, and only wait for longer time and attention to assume

scientific exactness, at least as much may be claimed for Politics, and the composite study may advance in logical perfection at an equal rate with the elementary studies.

The general result of these considerations is that there are a variety of solid reasons which account not only for the reputation acquired by Politics of being an inherently unscientific study, but also for the study itself having advanced only a very short way toward scientific completeness. But most or all of these reasons have been seen to be of a kind which hold out a good promise for the future, and thereby afford an ample encouragement to the use of a strictly logical method in political investigations, and to the attempt to create a scientific structure of ever-increasing completeness in this region, as well as in others more familiarly associated with the name of Science.

A science need not be built on universal, nor even upon general, propositions; and partial, particular, or even probable premises may justify conclusions, drawn with logical correctness, which may be a firm basis for action. Where truths are by their nature restricted in time and place, or where evidence is yet lacking to demonstrate their actual generality, the assemblage of such truths will carry with it a fragmentary and hypothetical character which may to some seem incompatible with the rigid demands of Science. But where the investigator himself proceeds in strict accordance with the severest logical requirements, conducting his ratiocination with the utmost precision, and distinguishing at all points the possible or probable from the certain, the universal or general from the particular, and proof from plausibility or mere conjecture, it matters little what name is given to the branch of inquiry concerned. It lacks no one of the essential elements and recommendations of the best and earliest-established of the physical sciences. Its terms are submitted to the same process of definition, its subject-matter to a like arrangement into groups and classes, genera and species, and the resulting propositions are reached by a course of reasoning as logically irrefutable.

There are, indeed, certain plain indications that the study of Politics is already, even by practical statesmen, being placed on a platform of far higher scientific exactness than ever before.

One of these indications is the large and discriminating use made of statistics. The collection and due use of statistics belong to very modern times; and owing to popular prejudices and social obstacles—such, for instance, as still exist in England with regard to the collection of agricultural and religious statistics—they have not yet received anything like the extension of which they are capable. Nevertheless, it has become the fashion for all the more advanced Governments to rival each other in the breadth, fullness, arrangement, and clearness of the numerical information they obtain on all the groups of national facts which are susceptible of being tabulated in a systematic shape.

These tables of statistics are periodically furnished by the Government, not only for purposes of contemplated legislation, but independently of all thought of immediate use. The fallacious use to which purely numerical facts can be put, with only too seductive a show of plausibility, is beginning to be fully acknowledged and guarded against. But the assurance that the registered number of births, deaths, and marriages, within a given period and area, as well as the periodical records of crime and disease, and, even more obviously, the tabulated increase or decrease of commerce, shipping, and manufactures of different sorts, may serve to point to the presence of general laws—that is, of permanent sequences of cause and effect—is a sufficient justification of the labor and expense involved in obtaining the severally-relevant statistics. The comparison between the numerical results obtained at one time and place and another, and between those presented in different countries, is becoming a political method increasing in prevalence and repute. In many quarters, indeed, the value of purely numerical estimates has been much exaggerated, and its peculiar liability to error, when made a basis of political reasoning, has been too much ignored. But when its limits of application are duly recognized, and care is taken to distinguish legal and political causes from those which are purely ethical or sociological, the study and use of statistics must be regarded as a most valuable ally, and an unmistakable proof of the scientific character of political studies.

Akin to the token which the enlarged use of statistics affords of the growing recognition of Politics as a true science, is the ever-increasing disposition, at the present day, to await, at any political crisis, whether legislative or administrative, the result of a patient examination of evidence as to the state of the facts and the previous history of the question.

It is now the practice in the more advanced countries to take, in the path of serious political change, no step which seems to be other than the next step onward in a course which has become habitual, without first nominating, by one process or another, competent persons to conduct a critical examination and to deliberate and report upon the matter. The most searching powers are often intrusted to this body of persons to enable them to inform themselves not only as to all the interests, in their several proportions, to be affected by the new policy, but as to the history of the general policy pursued in the past, and occasionally even as to the practice in other countries.

It often, indeed, happens that after a laborious investigation, lasting for months or even for years, the popular interest in the once-advocated policy is found to be exhausted, or diverted into new directions, and the thought of new legislation is abandoned, and a voluminous, costly, and invaluable report cast on one side. Such are among the inevitable accidents which retard the progress of Government.

But what is of importance to notice in this place is that the growing disposition to consult past and surrounding facts before inaugurating change belongs to the strictly scientific habit of mind; and if it is true that much laborious investigation seems for the time to be thrown away, yet it seldom happens that complicated and far-reaching changes are encountered without the assistance of a previous impartial and deliberate inquiry of the kind here adverted to. The scientific method, in Politics as elsewhere, is slowly and surely getting the better of the empiric.

## THE ECONOMIC FUNCTION OF VICE.

By JOHN McELROY.

FOR some inscrutable reason, which she has as yet given no hint of revealing, Nature is wondrously wasteful in the matter of generation. She creates a thousand where she intends to make use of one. Impelled by maternal instinct, the female cod casts millions of eggs upon the waters, expecting them to return after many days as troops of interesting offspring. Instead, half the embryotic *gadi* are almost immediately devoured by spawn-eaters, hundreds of thousands perish in incubation, hundreds of thousands more succumb to the perils attending ichthyic infancy, leaving but a few score to attain to adult usefulness, and pass an honored old age, with the fragrance of a well-spent life, in a country grocery.

The oak showers down ten thousand acorns, each capable of producing a tree. Three fourths of them are straightway diverted from their arboreal intent, through conversion into food by the provident squirrel and the improvident hog. Great numbers rot uselessly upon the ground, and the few hundreds that finally succeed in germinating grow up in a dense thicket, where at last the strongest smothers out all the rest, like an oaken Othello in a harem of quercine Desdemonas.

This is the law of all life, animal as well as vegetable. From the humble hyssop on the wall to the towering cedar of Lebanon—from the meek and lowly amœba, which has no more character or individuality than any other pin-point of jelly—to the lordly tyrant, man, the rule is inevitable and invariable. Life is sown broadcast, only to be followed almost immediately by a destruction nearly as sweeping. Nature creates by the million, apparently that she may destroy by the myriad. She gives life one instant, only that she may snatch it away the next. The main difference is that, the higher we ascend, the less lavish the creation, and the less sweeping the destruction. Thus, while probably but one fish in a thousand reaches maturity, of every 1,000 children born 604 attain adult age. That is, Nature flings aside 999

out of every 1,000 fishes as useless for her purposes, and two out of every five human beings.

Many see in this relentless weeding out and destruction of her inferior products a remarkable illustration of the wisdom of Nature's methods. What would they think of a workman so bungling that two fifths of the products of his handicraft were only fit for destruction?

The "struggle for existence" is a murderous scramble to get rid of this vast surplusage. The "survival of the fittest" is the success of the minority in demonstrating that the majority are superfluous. It is the Kilkenny-cat episode multiplied by infinity. It will be remembered that the whole trouble arose from their common belief that two cats were a surplus of one for the Kilkenny environment.

Darwin's theory recognizes in this super-fecundity of Nature her most potent agency for improvement. He says, in effect, that the impossibility of providing subsistence for more than a fraction of the multitudinous creation causes a mortal struggle, in which the weaker and inferior are exterminated, and only the stronger and superior survive. These in turn have offspring like the leaves of the forest, which in like turn are winnowed out by alien enemies, and ruthless reciprocal extermination, the process going on continually with the sanguinary regularity of the King of Dahomey's administration of the internal economy of his realm. The benignity of this method of arranging the order of Nature is not so apparent as a member of the Society for the Prevention of Cruelty to Animals might desire.

But our opinion of this law is not cared for. The main importance attaches to the recognition of the fact that it *is* a law. Its application to society is obvious: Since the propagation of human beings goes on with entire recklessness as to the quality of the product and the means of subsistence, some strong corrective is absolutely necessary to establish limits to population, and to secure the continued development of the race. If every begotten child lived to the average age of forty, in a very few years there would not be standing-room on the earth for its people! Even with such limited propagators as the elephant, each female of which produces but six offspring in her bearing period of ninety years, we are told that, if the species had no parasitic or other enemies, it would only be 740 years until elephants overran the earth. Where, then, should we assign limits to the productiveness of the 700,000,000 human females on the globe, each of whom is capable of producing twenty children in her thirty years of bearing? If, too, every child had the same chance of life, without reference to its mental and physical fitness to live, humanity would soon become a stagnant slough of vicious vitality. As there are only food and room for the best, and as the development of the race demands it, only the best survive, and continue the work of propagation. The rest are destroyed. By "the best" is understood those having that harmony of mental and

physical development which brings them most nearly into accord with natural laws.

Below the human strata, superabundant generation is neutralized by the simple device of having every organism prey upon some other one. In her ten years of fruitful life the female cod lays 50,000,000 eggs. If nothing thwarted the amiable efforts of herself and offspring to multiply and replenish, they would shortly pack the ocean as full as a box of sardines. But, while giving one animal the desire and capacity to produce 50,000,000 lives, Nature has given other animals the desire and capacity to annihilate those 50,000,000 lives. So, all through the animal kingdom it is nearly a neck-and-neck race between Production and Extermination.

Man alone is practically exempt from what is apparently an inseparable condition of all other forms of animal life. While he preys on a myriad of created things, there is no created thing that preys on him, and assists in keeping his excessive reproductiveness within the limits of subsistence. Most singular of all, not even a parasite wages destructive warfare against him.

This absence of destructive enemies must be compensated for in some way, and it is accomplished by making vicious inclinations the agents to weed out the redundant growths, and to select for extermination those which are inferior, depraved, weak, and unfit for preservation or reproduction.

If five human beings are procreated where there is present room and provision for but three, how are the surplus two to be picked out and exterminated? Of course, each one of us feels entirely competent to pick out in his own community the persons who could be best spared, but public opinion is at present hostile both to any practicable plan of making the necessary thinning out, and also to lodging the power of selection in the hands of even those of us best qualified for the duty.

Fortunately, the surplus ones relieve us from embarrassment on this score, by selecting and exterminating themselves. Their methods of suicide cover a wide range of expedients, but all are very effectual. Most beneficent of any of the facts that we have to consider is the one that each of those chosen for extermination embraces his fate with eagerness, under the delusion that he is about to enhance his own happiness. Immoderate use of stimulants, and the various excesses and vital errors which are grouped under the general head of "dissipation," a "life of pleasure," or the still more expressive phrase, "a short life and a merry one," etc., are favorite plans of self-annihilation, and leave little to be desired in the completeness with which they do their work.

Competent English statisticians estimate that, after a man has begun drinking beer in large quantities, it takes him 21·7 years to kill himself, and a whiskey-drinker shortens the time to 16·1 years. In-

temperance, being among the milder vices, kills slowly. Sexual sins slay more rapidly, and the higher grades of vice do their work with a swiftness proportioned to their flagrancy. The Psalmist says, "Bloody and deceitful men shall not live out half their days," but police records will show that David materially overstates the average. "One quarter their days" would approach much nearer exactness.

Returning to the major premise, that the "survival of the fittest" means the selection and preservation of those individuals who are most nearly in harmony with the conditions of their environment, and that the progress of the race or species involves the destruction of the weaker and inferior, who are not in such harmony, the conclusion follows that any aberration toward vice shows such a discordance in the individual with the laws of his environment as marks him as inferior, weak, and obstructive of the race's development.

Vice is not so much a cause as an effect—not so much a disease as a symptom. Vice does not make a nature weak or defective: a weak and defective nature expresses its weaknesses and defects in vice, and that expression brings about, in one way or another, the sovereign remedy of extermination.

Temperance agitators fill our ears continually with wails as to how the "demon Alcohol is yearly dragging down to dishonorable graves hundreds of thousands of the brightest and fairest of our land." This is supreme nonsense. With very few exceptions, every one who goes to perdition by the Alcohol route would reach that destination by some other highway, if the Alcohol line were not running.

Every man whose sloth or improvidence has brought himself and his family to beggary, every thieving tramp upon the highways, every rascal in the penitentiary, every murderer upon the gallows, hastens to plead, "Whisky brought me to this!" because he knows that such a plea will bring him a gush of sloppy sympathy not obtainable by any other means. But whisky makes no man lazy, shiftless, dishonest, false, cowardly, or brutal. These must be original qualities with him. If he has them, he will probably take to whisky—though not inevitably—which then does the community the splendid service of hurrying him along to destruction, and of abridging their infliction upon the public. People who have done much in the way of reforming drunkards have been astonished to find how little real manhood remained after eliminating whisky from the equation. They have supposed the manhood to be only obscured, and have been disheartened to find how frequently it happens to be demonstrated that there was never enough of it to pay for the trouble of "saving the victim of intemperance."

If, as the temperance agitators insist, "intemperance is yearly dragging a hundred thousand of the men and women of our country down to the grave," then a love of scientific truth compels the statement that intemperance, while doing some harm, as is usually the case

with natural agents, is also doing an immense amount of good. By far the greater portion of those who thus succumb to alcoholization, and to the deadly practices that usually accompany it, are thieves, thugs, prostitutes, gamblers, sharpers, ruffians, and other members of the criminal and *quasi*-criminal classes, upon whom whisky accommodatingly performs the office of judge and executioner, cutting their careers off at an average of five years, where, without this interposition, they would be extended to possibly twenty or thirty. The certainty and celerity with which it ferrets out and destroys these classes recommends it strongly over the ordinary processes of justice.

It was exceedingly unfortunate for the community that all the leaders in the James gang were strictly temperate men. Had it not been so, their career, instead of extending over twenty terrible years, would have been cut short inside of five. Uncontrollable predilections for whisky and the society of strange women brought about the destruction of nearly all of the band, who from time to time were slain by each other's hands or those of justice. Temperance and chastity in a rascal of any kind mean an immense amount of mischief to the community. Fortunately, they are quite rare.

During the ages of terrible oppression of the European people, which culminated in the French Revolution, the main amelioration of the hardships endured was found in the vices of the oppressors. The sword of the duelist, the picturesque horrors of *delirium tremens*, and the loathsome *mal de Naples*, continually swept away hecatombs of tyrant lordlings, and frequently obliterated whole families. In fact, no aristocratic family ever withstood these adverse influences very long. Extinction came as promptly and as certainly as the curculio to the ripening plum.

The student of French and English history is continually astonished at the brief time in which noble names remain in view. They rise to dazzling eminence on one page, and on the next go down to oblivion. One rarely finds a name of a century or two ago mentioned in any of the European news of to-day. Mr. Freeman, the eminent English historian, shows conclusively that, in spite of the perennial vaunt of ancestors who "came over with the Conqueror," and of Tennyson's musical mendacity about the "daughter of a hundred earls," the families who can trace back to even so recent a date as the reign of the Stuarts are quite rare. Idleness, luxury, and more or less flagrant debauchery have done their appointed work in removing the deteriorated forms of human life from the world, that their room might be had for more acceptable growths.

Society has been most aptly likened to a vat of good wine, which is all scum and froth at the top, dregs and sediment at the bottom, and good, pure, clear liquor in the middle. Vice does admirable work in skimming away the supernatant scum, and in drawing off the dregs and settlings. Unceasing fermentation seems to be a condition neces-

sary to the health of society. The humblest work incessantly to lift themselves into the ranks of the middle classes. The middle classes strive as earnestly to make themselves plutocrats, aristocrats, and lordlings. This passion for worldly advancement is one of society's most powerful engines for good. When a man at last reaches the social summit, he desists from further efforts at improvement, or, if this period comes too late in life, his children do it after him. He becomes like a man who has struggled forward to the head of a procession, and then refuses to march another step. Some vice speedily removes him, and clears the ground for another man to come to the front, who is also removed summarily when he becomes obstructive. Were it not for this, the upper stratum of society would speedily become so crowded that ascent to it would be impossible, all healthful, ambitious motive be taken away from the middle and lower classes, stagnation follow, and society perish from congestion.

History is full of illustrations of the benefits of vice in assisting to shape the destinies of nations and peoples. Take, for example, the Bourbons, whose stupidity and tyranny have passed into a proverb. In the last century their worse than worthless carcasses filled nearly every throne in Southern Europe. They seemed to breed like wolves in a famine-stricken land, and their fangs were at every people's throat. Fortunately, they had vices. Wine and lechery did what human enemies could not. The pack of wolves rotted away like a flock of diseased sheep. The mortality was so great that for a long time French kings were succeeded by their grandsons, and great-grandsons, their sons all burning themselves out before the time came for ascending the throne. The unutterably vile life of Louis XV was terminated by the small-pox, communicated to him in the course of a most disgraceful amour. His grandson, who succeeded him, had no destructive vices, and so the people were compelled at last to resort to the guillotine to rid themselves of him. The vast problem before the French in 1790 would have been greatly simplified if Louis XIV had been a short-lived *débauché* like his father and two brothers. The healthy German blood of his Saxon mother corrected somewhat the virus in the Bourbon veins, and he lived to become an intolerable cumberer and obstructive.

The only Bourbon still remaining on a throne is the King of Spain, with whom the race, as a royal family, will probably become extinct. His teeth are on edge from the sour grapes of unchastity which his fathers ate. Like his mother, the notorious Isabella II, his sisters and cousins, and indeed every one of the Bourbons, the scrofula, into which the ancestral syphilitic taint has been modified, has made of him a mass of physical decay. In his mother it has shown itself in a very disgusting cutaneous disease, which she has for years tried to ameliorate or cure, in a truly Bourbonish way, by wearing the underclothing of a nun of high repute for piety. His sisters and kinsmen

all have some one or more of the scrofula's varied physical degradations or sickening deformities, and occasionally one of them goes out like an ill-made candle.

A few years ago the people of Holland were threatened with a most serious calamity. Depraved heredity, unwise sexual selection, or some other controlling cause, had resulted in the production, as the Prince of Orange—the crown prince—of an individual of a weak, inferior, and depraved nature. His was such a nature as, on a throne, becomes a fountain of numberless oppressions and evils, and rarely fails to goad the unhappy subjects into rebellion, attended with the usual frightful losses of life and property and vast sorrows. Fortunately, he had destructive vices. The appetites of these led him to Paris. A few years of riot and debauchery sapped away the dangerous life of "Lemons," as his worthless boon companions nicknamed him, and he died as the fool dieth. The only harm he was able to do was the indirect damage of a bad example, and the good people of the Netherlands were rid of a possible Louis XV, at no greater cost than that of some years of extravagant life in the French capital. His father's youthful excesses and present *penchant* for pretty ballet-girls have rendered it wholly improbable that there will be any other heirs to the Dutch throne, and so the country will shortly glide into a republic, without any of the wrench and sanguinary convulsions that usually attend such political transitions. The superior economy and other advantages of a Parisian brothel over civil war as a political means are obvious to the naked eye.

The most commendable feature of this self-pruning of the objectionable growths in society is that the victims destroy themselves under the hallucination that they are drinking the richest wine of earthly pleasure. When execution can be made a matter of keen relish to the condemned, certainly nothing is wanting on the score of humanity.

I anticipate the objection that slaying bad men by means of their own vicious propensities brings much misery to those connected with them. But then all innocent persons connected with bad men are fated to suffer in exact proportion to the closeness of the connection, whether the bad men are destroyed or not. Weak, selfish, perverted, and criminal men always inflict misery upon their relatives and associates. This is not usually intensified by their being also drunkards, or *débauchés*. It is also true that no one of Nature's methods of extinction is pleasant to those connected with the victim. A thief or a thug providentially dying with the *delirium tremens* is certainly quite as bearable a sight to those before whose eyes it may come as the spectacle of a virtuous man, the sole support of his family, slowly wasting away with consumption, in spite of all that loving services and agonizing sympathy can do to retain for him a life that is of so much value to all.

To the next objection, that the practice of vice is not inevitably suicidal, since many rascals live to attain as green an old age as the most righteous, it is sufficient to say that, plentiful as these exceptions may occasionally seem, their proportion to the whole number is at least as small as that of the exceptions to any other general law of biology. The policeman on the next corner will bear decided testimony that the number of scoundrels who survive their thirtieth year is astonishingly small, and he can point out any number of very troublesome members of the community who are ending their lives in penitentiary or poor-house hospitals, at an age when well-behaved men are just entering upon the serious business of life.

It is also demonstrable that the proportion of vicious men to the whole population is much less to-day than at any previous period in the history of the race. This shows conclusively the improvement of society by the self-destructiveness of vice. The proportion of bad men is steadily diminishing, because bad men die sooner, and propagate fewer, than good ones.

## PROGRESS OF THE BACKBONED FAMILY.*

By ARABELLA B. BUCKLEY.

THERE is much uncertainty as to how the backboned or vertebrate animals began; but the best clew we have to the mystery is found in a little, half-transparent creature, about two inches long, which is still to be found living upon the English shores and the Southern Atlantic coast of the United States. This small, insignificant animal is called the "Lancelet," because it is shaped something like the head of a lance; and it is in many ways so imperfect that naturalists believe it to be a degraded form, like the acorn-barnacle—that is to say, that it has probably lost some of the parts which its ancestors once possessed. But, in any case, it is the most simple backboned animal we have, and shows us how the first feeble forms may have lived. Truly, it is only by courtesy that we can call him a backboned animal, for all he has is a cord of gristle, pointed at both ends, which stretches all along the middle of his body above his long, narrow stomach; while above this, again, is another cord containing his nerve-telegraph.

There are large fishes, too, which have this cartilaginous backbone. The young shark has nothing but a rod of gristle or cartilage, and, though he is one of the strongest of sea-animals, *he retains this gristly state of his skeleton throughout his life;* however much he may strengthen it by hard matter, it never becomes true bone.

* Abridged from Miss Buckley's book, entitled "Winners in Life's Race; or, The Great Backboned Family," from which also the illustrations are borrowed.

The first feeble ancestors of the shark and the sturgeon appear at a time when the crustaceans were the most powerful animals in the world, and the huge, lobster-like Pterygotus was the monarch of the

FIG. 1.

seas. The plated-scaled fish which existed at the same time were clumsy creatures, for their skeletons were probably feeble, and their armor-like shields were heavy. So, as history went on, they gradually gave way, becoming smaller and rarer, while the more active little shark-like animals gradually grew strong and powerful, and from them are descended the giant sharks of to-day.

The powerful gristly-boned fishes are much excelled in agility by the herring, the salmon, and their other bony companions, which move with much less effort in the water, and so have naturally made their way into all parts of the rivers and seas. But where have they come from? We know very little of their early history, but what little we do know leads us to think that long ago they branched off from the enameled-scaled fish, and struck out a path of their own, to make the most of the watery world.

If we wanted to pick out the strangest and strongest proof of how the shape of fish is altered to suit their wants, we need seek no further

than the flat-fish. The young sole, when it comes out of the egg, is not flat like the young skate, but a very thin, spindle-shaped fish, something like a minnow. He is then about the size of a grain of rice, very trans-

FIG. 2.

parent, and lives at the top of the sea. He has one eye on each side, like other fish, only one eye is higher up than the other, and the single fin on its back and the one under its body reach almost from head to tail. In this way he swims for about a week, but he is so thin and deep, and his fins are so small, that swimming edgewise is an effort, and soon he falls down on one side, generally the left, to the bottom of the sea. Many times he rises again, especially at first, till he has got used to breathing at the muddy bottom, and meanwhile the eye that lies underneath is gradually working its way round to the upper side, his forehead wrinkles so as to draw the under eye up, while his whole head and mouth receive a twist which he never afterward loses. His skeleton, it must be remembered, is still very soft, and the bones of his face are easily bent; and at last this eye is screwed round, and as he lies at the bottom he can look upward with both eyes, and save the under one from getting scratched by the sand, as it must have done if it had remained below.

It is clear that if the backboned animals were ever to live upon land, after they had begun their career in the water, there must have been some among them which learned gradually to give up water-breathing, and to make use of free air; and we shall not have far to seek for creatures which will help us to guess how they managed it.

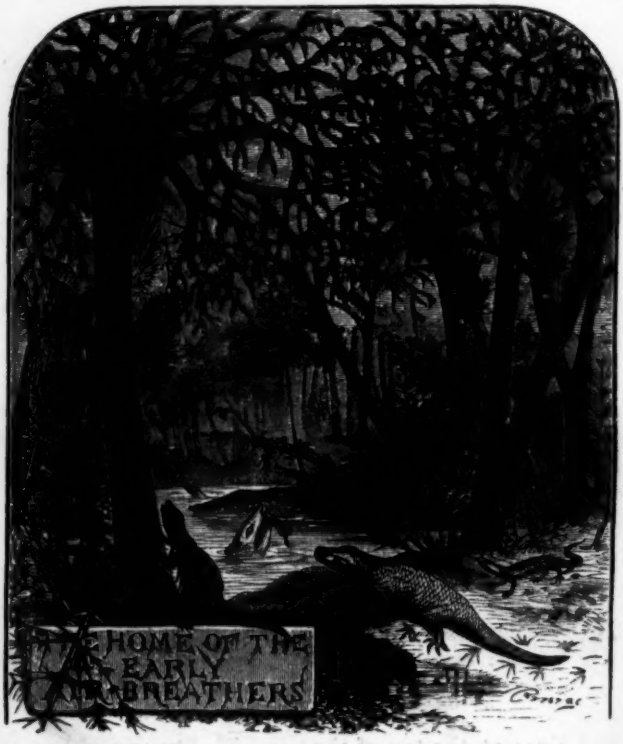


FIG. 3.

The common tadpole is to all intents a fish. He swims with a fish's tail; he gulps in water at his mouth, passing it out at the slits in his throat after it has poured over his fish's gills. Moreover, he has a fish's heart, of two chambers only, which pumps the blood into these gills to be freshened, while, like the lamprey, he has a gristly cord, enlarged at the end to form a gristly skull, a round sucking mouth, and no limbs. As he grows bigger and more active week by week, two little bumps appear, one on each side of his now bulky body, just where it joins the tail. These bumps grow larger every day, until, lo! some morning they have pierced through the skin, and two tiny hind legs are working between the body and the tail. In about another week the front legs appear, and we have a small four-legged animal with a lamprey's tail.

During this time a bag has been forming inside, at the back of the

throat, which afterward divides into two, forming a pair of lungs, which he uses when out of the water, though still using his gills when below. Little by little the blood-vessels going to the gills grow smaller, and those going to the lungs grow larger; while the fish's two-chambered heart is dividing into three chambers—one to receive the blood from the body, another to receive it from the lungs, and one to drive this blood back again through the whole animal. Now that he can leap and swim with his legs, his tail is no longer of use to him, and it is gradually sucked in, growing shorter and shorter, till it disappears. Thus our backboned animal has succeeded in getting out of the water on to the land.

Fig. 4.

If we glance back to the far-off time when the ancient fishes were wandering round the shores and in the streams of the coal-forests, we find that the *amphibia* were not then the small, scattered groups they are now, but huge and powerful creatures, which sported in the water or wandered over the land with sprawling limbs, long tails, and bones on which gills grew, while their heads were covered with hard, bony plates, and their teeth were large, with folds of hard enamel on the surface.

And now the transformation is complete, for, when we pass on to the next division of backboned animals, the "reptiles," we hear nothing more of gills, nor air taken from the water, nor fins, nor fishes' tails. We shall all allow that the tortoises are the most singular of any. Slow, ponderous creatures, with hard, bony heads, wide-open, expressionless eyes, horny beaks, and thick, clumsy legs, the tortoises seem, at first sight, to be only half alive, as they lumber along, carrying their heavy shell, and eating, when they do eat, in a dull, listless kind of way. This sluggishness would certainly be their ruin, in a bustling, greedy world, if it were not for the strong box in which they live. You would hardly guess that the shell of the tortoise is part of his skeleton. But it is so. The arched dome which covers his back is made of his backbone and ribs, and the shelly plates arranged over it are his skin hardened into horny shields, which, in the hawk's-bill turtle, form the tortoise-shell which is peeled off for our use; while the flat shell under his body is the hardened skin of his belly, and the bones which belong to it.

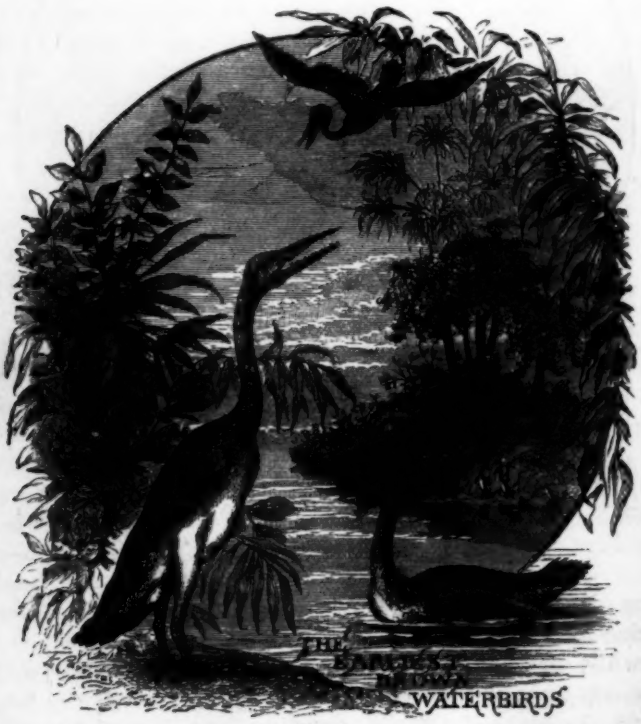


FIG 5.

It is not without some struggle that the cold-blooded reptiles have held their own in the world, nor is it to be wondered at that only four

types—tortoises, lizards, crocodiles, and snakes—should have managed to find room to live among the myriads of warm-blooded animals which have filled the earth. These four groups have made a good fight of it, and many of them even make use of warm-blooded animals as food. The tortoises, it is true, feed upon plants, except those that live in fresh water, and feed chiefly on fish, snakes, and frogs, while most of the lizards are insect-feeders. But the crocodile, as he lurks near the river's edge, and the snake, when he fastens his glittering eye on a mouse or bird, are both on the lookout for animals higher in the world than themselves.

We come now into quite a new life, for we are going to wander among the conquerors of the air, who have learned to rise far beyond our solid ground, and to soar, like the lark, into the clouds, or, like the eagle, to sail over the topmost crags of the mountains, there to build his solitary eyrie.

In those far by-gone times, when the huge land-lizards browsed upon the trees, the birds living among them were much more like them in many ways than they are now. Of water-birds there were some about the size of small gulls, which flew with strong wings and had fan-shaped tails, but had teeth in their horny jaws, set in sockets like those of the crocodile, while their backbones had joints like those of fishes rather than birds; and with them were other and wingless birds rather larger than our swans, but more like swimming, fish-eating ostriches.

In these and many other points the early birds came very near to the reptiles—not to the flying ones, but to those which walked on the land. And now, perhaps you will ask, Did reptiles, then, turn into birds? No, since they were both living at the same time, and those reptiles which flew did so like bats, and not in any way like the birds which were their companions. To explain the facts, we must go much further back than this. If any one were to ask us whether the Australian colonists came from the white Americans or the Americans from the Australians, we should answer, "Neither the one nor the other, and yet they are related, for both have sprung from the English race." In the same way, when we see how like the ancient birds and reptiles were to each other, so that it is very difficult to say which were bird-like reptiles and which were reptile-like birds, we can only conclude that they, too, once branched off from some older race which had that bone between the jaws, that single neck-joint, and the other characters which birds and reptiles have in common.

But where have the feathers come from—those wonderful, beautiful appendages without which the bird could not fly? They are growths of his skin, of the same nature as the scales of reptiles, or those on the bird's own feet and legs; and on some low birds, such as the penguins, they are so stiff and scale-like that it is often difficult to say where the scales end and the feathers begin. All feathers, even

the most delicate, are made of horny matter, though it splits up into so many shreds as it grows that they look like the finest hair, and Dr. Gadow has reckoned that there must be fifty-four million branches and threads upon one good-sized eagle's feather.

FIG. 6.

From their skeletons and feathers which we find, we know that the strange land-birds which perched on the trees at the time that large reptiles were so numerous had not a fan-shaped tail, made of feathers growing on one broad bone, as our birds have now, but they had *a long tail of many joints like lizards*, only that each joint carried a pair of feathers, and like lizards, too, they had *teeth in their jaws*, which no living bird has. They must have been poor fliers at best, these earliest known birds, for their wings were small and the fingers of their hand were separate more like lizards' toes, two of them at least having claws upon them, while their long, hanging tail must have been very awkward compared to the fan-shaped tail they now wear.

Our backboned animals have now traveled far along the journey of life. The *fish*, in many and varied forms, have taken possession of the seas, lakes, and rivers; the *amphibia* fill the swamps and the debatable ground between earth and water; the *reptiles* swarm in the

tropics, and even in colder countries glide rapidly along in the warm sunshine, or hide in nooks and crannies, and sleep the winter away; and the *birds*—the merry, active, warm-hearted birds—live everywhere.

Yet still the great backboned division is not exhausted; on the contrary, the most powerful if not the most numerous group is still to

Fig. 7.

come—the *mammalia*, or milk-giving animals. Let us first notice two important changes which give them an advantage over other backboned creatures. We have found the fish casting their eggs out into the water, and, as a rule, taking no more thought of them; so it was again with the frogs, so with the reptiles, whose eggs, even when carefully buried by the mother, are often devoured by thousands before the little ones have a chance of creeping out of the shell. And with the birds, in spite of the parents' care, more eggs probably are eaten by snakes, weasels, field-rats, and other creatures, than remain to be hatched.

Now, the cat and the cow, as we all know, do not lay eggs as birds do; but the mother carries the young within her body till they are born, perfectly formed, into the world. And when at last her little

ones see the light, the mother has nourishment ready for them: part of the food which she herself eats is turned into milk, and secreted by special glands, so that the newly-born calf or kitten is suckled at its mother's breast till it has strength to feed itself.

Among the earliest milk-givers must have been the ancestors of the curious pouched creatures of Australia, the "marsupials," which have a large pouch of skin, into which the mothers put their little ones when they are less than two inches long, and so imperfect that their legs are mere knobs, and they can do nothing more than hang on to the nipple with their round, sucking mouths, as if they had grown to it.

There the little ones hang, day and night, and their mother, from time to time, pumps milk into their mouths, while they breathe by a peculiar arrangement of the windpipe, which reaches up to the back

FIG. 8.

of their nose. Then, as they grow, the pouch stretches, and by-and-by they begin to jump out and in, and feed on grass as well as their mother's milk.

Other singularly old-fashioned animals may be found in a Brazilian forest. The furry little opossum, the dreamy sloth, the strange ant-

bear, and the armadillo, whose back is covered with long shields like the crocodile.

Having now taken leave of the curious pouch-bearers and the strange primitive sloths and armadillos, we find ourselves left to deal with an immense multitude of modern mammalia, which have spread in endless variety over the earth, and which may be divided into five great groups: the *Insectivora*, or insect-eaters; the *Rodents*, or gnawers; the climbing and fruit-eating lemurs and monkeys; the *Herbivora*, or large vegetable-feeding animals; and the *Carnivora*, or flesh-eaters.

It is clear that the *Rodents* and *Insectivores* do not hold their place in the world by strength or audacity. Both lowly groups, of simple structure and with comparatively feeble brains, they have chiefly escaped destruction from higher forms by means of their nocturnal and burrowing habits or arboreal lives, and the marvelous rapidity with which they breed, combined with their power of sleeping without food during the winter in all cold countries. But the insect-eaters have no water-animal to match the beaver among rodents in sagacity or engineering. With his chisel-like front teeth he gnaws a deep notch in the trunk of a larch or pine or willow, and then, going round to the other side, begins work there till the trunk is severed and falls heavily on the side of the deep notch, and therefore away from himself. He always makes the deep notch in the trunk on the side near the water, so that the tree in falling comes as near as possible to the stream. Then, after stripping off the bark and gnawing the trunk into pieces about six feet long, he uses his fore-paws and his teeth to drag them into position to build his dam. He does not always clear away all the branches, but he and his companions place the logs with these lying *down* the stream, so that they act as supports to resist the current and prevent the dam being washed away. Thus they make a broad foundation, sometimes as much as six feet wide, and upon this they pile logs and stones and mud till they have made a barrier often ten feet high and more than a hundred feet long. The lighter branches he uses to make his oven-shaped lodge, laying them down in basket-work shape, plastering them with mud, grass, and moss, and lining the chambers with wood-fiber and dry grass.

There remain to be noticed two groups of much larger animals: first, the *Herbivora*, or grass-feeders; and, secondly, their great enemies, the *Carnivora*, or flesh-feeders. We shall see that the vegetable-feeders have filled every spot where they could possibly find a footing, and if we could only trace out their pedigree we should be surprised to find how wonderfully each one has become fitted for the special work it has to do. But three things they all require and have. The *first* of these is a long face and freely-moving under jaw, with large grinding teeth to work up and chew the vegetable food; the *second*, a capacious stomach to hold and digest green meat enough to

nourish such bulky bodies; and, the *third*, good defensive weapons to protect themselves against each other and against their enemies.

FIG. 9.

In the three-toed group of the vegetable-eaters, the horse has the most interesting history. It was in America that the tribe began, for there we find that tiny pony not bigger than a fox, with four horn-covered toes to his front feet (and traces of a fifth), and three toes on his hind ones. Then, as ages went on, we meet with forms with only three toes on all the feet, and a splint in the place of the fourth on the front ones. In the next period they have traveled into Europe, and we find larger animals with only three toes of about equal size. One more step, and we find the middle toe large and long, and covered with a strong hoof, while the two small ones are lifted off the ground. Lastly, in the next forms, the two side-toes became mere splints; and, soon after, well-built animals with true horse's hoofs abounded, the one large hoof covering the strong and broad middle toe. For what we call a horse's knee is really his wrist, and just below it we can still find under the skin those two small splints running down the bone of the hand, while the long middle finger, or toe, with its three joints, forms what we call the foot. It is by these small

splints that the horse still reveals to us that he belongs to the three-toed animals.

A far different race from the *Herbivora* is the large army of flesh-feeders, which we find throughout all past ages harassing and destroying the vegetable-feeders on all sides. And yet it would not be fair to speak of these larger flesh-feeding animals as if they had worked nothing but evil to their more peaceful neighbors, for how would Life educate her children if she put no difficulties in their way to be conquered, no sufferings to be endured? It was in the long struggle for life that the animals with the largest and strongest horns got the upper hand, that the swiftest horses or antelopes survived and left young ones; while we must remember that it is more often the sickly, worn-out, and diseased animals that fall a prey to the devourers, and their life is ended far less painfully than if they dragged themselves into some hole to die.

"*On revient toujours à ses premiers amours*," says the French song. But who would have thought that, after rising step by step above the fish, and tracing the history of the backboned animals through their development in the air and over the land till we brought them to a state of intelligence second only to man, we should have to follow them back again to the water and find the highly-gifted milk-givers taking on the form and appearance of fishes? Nevertheless it is so, for seals and whales are as truly flesh-eating milk-givers as bears and wolves. "Do you really mean, then," exclaim nearly all people who are not naturalists, "that a whale is not a huge fish?" Certainly I do! A whale is no more a fish than crocodiles, penguins, or seals, are fishes, although they too live chiefly in the water.

A whale is a warm-blooded, air-breathing, milk-giving animal. Its fins are hands with finger-bones, having a large number of joints; its tail is a piece of cartilage, and not a fish's fin with bones and rays; it has teeth in its gums, even if it never cuts them; and it gives suck to its little one just as much as a cow does to her calf. Nay, the whale-bone whales have even the traces of hind legs entirely buried under the skin, and in the Greenland whale the hip-joint and knee-joint can be distinguished with some of their muscles, though the bones are quite hidden and useless.

There was once a time when the great army of milk-givers had its difficulties and failures as well as all the other groups, only these came upon them not from other animals, but from the influence of snow and ice.

For we know that, from the time of tropical Europe, a change was creeping, during long ages, over the whole northern hemisphere. The climate grew colder and colder, the tropical plants and animals were driven back or died away, glaciers grew larger, and snow deeper and more lasting, till large sheets of ice covered Northern Europe, and in America the whole of the country as far south as New York.

True, there were probably warmer intervals in this intense cold, when the more southern animals came and went, for we find bones of the hippopotamus, hyena, and others buried between the glacial beds

FIG. 10.

in the south of England. But there is no doubt that at this time numbers of land-animals must have perished, for in England alone, out of fifty-three known species which lived in warmer times, only twelve survived the great cold, while others were driven southward, never to return.

Moreover, when the cold passed away, and the country began again to be covered with oak and pine forests where animals might feed and flourish, we find that a new enemy had made his appearance. Man—active, thinking, tool-making man—had begun to take possession of the caves, making weapons out of large flints bound into handles of wood, and lighting fires by rubbing wood together, so as to protect himself from wild beasts and inclement weather.

Many and fierce must have been his conflicts, for the wild beasts were still strong and numerous, and man had not yet the skill and weapons which he has since acquired. But, rough and savage though he may have been, he had powers which made him superior to all

around him. He had a brain which could devise and invent, a memory which enabled him to accumulate experience, and a strong power of sympathy which made him a highly social being, combining with others in the struggle for life.

FIG. 11.

At one time naturalists looked upon the animal kingdom as complete from the beginning, and, when it became certain that different kinds of animals had appeared from time to time upon the earth, the naturalists of fifty years ago could have no grander conception than that new creatures were separately made (they scarcely asked themselves how), and put into the world as they were wanted.

But a higher and better explanation was soon to be found, for there was growing up among us the greatest naturalist and thinker of our day, that patient searcher after truth, Charles Darwin, whose genius and earnest labors opened our eyes gradually to a conception so deep, so true, and so grand, that side by side with it the idea of making an animal from time to time, as a sculptor makes a model of clay, seems too weak and paltry ever to have been attributed to an Almighty Power.

# CURIOSITIES OF SUPERSTITION.

By FELIX L. OSWALD, M. D.

III.

SOME international superstitions have a symbolic significance. The vampire-fable, for instance, typifies the insufficiency of human life, the sleep-disturbing consciousness of its unattained purposes. Like the visits of the White Lady, the rambles of the posthumous night-walker have generally a definite object, the gratification of revenge or desire, or of some special crotchet, like that of the Turkish horse-ghoul (mentioned by the traveler Kohl), who amused himself by galloping the race-horses of his former master. Mental aberrations can become epidemic, and the vampire-delusion seems to be as contagious as the witchcraft-insanity. In Transylvania the "climate of opinion" appears to affect even foreigners. In 1859 an Austrian notary of Klausenburg recorded the testimony of forty-eight deponents of various nationalities, who attested the *post-mortem* appearance of one Fedor Radotzek, a brevet captain of the *Grenz-Corps*, or Military-Frontier Guards. About two years after the funeral of the brevet captain, the neighbors attended a birthday-party at the house of his widow, and toward evening some of them were standing in the open porch, talking to one of his sons, when they saw the old man himself come round the corner and enter the garden-gate. A few minutes after the garden was crowded with a mass-meeting of citizens, in a pardonable state of excitement, for the twilight was still clear enough to remove all doubts about the identity of the visitor. He had taken a seat on the garden-bench, making himself at home, as if nothing had happened; but, on being taken to task for the eccentricity of his conduct, he had the good sense to re-die on the spot, and met his fate like a well-behaved corpse, when a couple of priests took him in charge and hustled him off the premises.

Vampirism prevails all over Russia, Persia, Greece, Bohemia, and Poland, but especially in the Danubian Principalities, where the wealthy families of the last century often buried their dead in sheet-iron-lined coffins of the heaviest oak-plank, while the poor would sometimes fetter or even hamstring their deceased relatives, to prevent them from abusing their feet for posthumous excursions. It is one of the few dogmas which the Moslem share with their Christian neighbors. There is a variety of maladies, chlorosis and hectic fever, for instance, which the Turkish beldames unhesitatingly ascribe to the activity of a ghoul; and after the massacre of Chios the Capitan Pasha ordered the bodies to be burned, "lest they should leave their graves." For a similar reason, perhaps, the judges of the Holy Inquisition roasted their victims; they believed, with Aristotle, that "fire disembodies the principle of

life, and restores the peace of the original elements." The Parsees worship in fire the purifying principle of Nature. Their millennium, like that of the Nihilists, will be preceded by a general explosion, a thorough actual cautery of earthly sores, and uncremated corpses will have to await the day of that final world-purgatory.

The vampire-superstition has been traced back to the earliest centuries of the Christian era, when the Nature-worship of ancient Europe had to yield to the dreary asceticism of the new creed, and the ancient divinities and their retainers had to wander homeless—in the North as followers of the Wild Huntsman, and in the South as night-hags and ghouls, like the Lamia of that weird and wonderful ballad, Goethe's "Bride of Corinth," which his rival, Heine, calls the "lyrical masterpiece of European poetry." A citizen of Corinth, a recent convert, betroths his daughter first to a young Athenian, and next to the "bridegroom of the Church," i. e., shuts her up in a nunnery, where they kill her with prayers and penances. Bridegroom number one arrives unexpectedly one evening; explanations are postponed to the next day, and in the mean time the guest is consigned to a room formerly occupied by his lost bride. During the night her mother hears stealthy footsteps and a whispered conversation, and, impelled by an irresistible curiosity, she opens the door of the guest-chamber. A vampire, caught *in flagrante*, confronts her, and she recognizes her own daughter, who, instead of collapsing at the sign of the cross, turns upon her with fierce reproaches, admits the fatal consequences of her visit, mentions other victims, but finally suggests the remedy—a Grecian funeral-pile. Her body, she says, has to be removed from the stifling cloister-vault, and cremated in due form, together with the corpse of her lover:

> "When the stake-fires blend,
> When the sparks ascend,
> Shall our spirits join the ancient gods."

In the mountains of Upper Austria the natives dread the boding voice of the *Klage*, a spectral Cassandra who frequents the desolate highlands of the Wiener Wald and the eastern Alps. He who meets her meets his death; her voice presages imminent misfortune, or afflicts the hearer with chronic hypochondria, for the echo of her wail will haunt the ear forever. A precisely analogous spook, the *llorona* (from *llorar*, to *weep* or *mourn*), infests the Sierras of old Spain, while *La Pleureuse* bemoans the sorrows of life on the French side of the Pyrenees. This concomitance of highlands and pessimism seems rather paradoxical; but mountaineers are mostly autochthones (like the Basques, Gaelic Scotch, Circassians, Ghebirs, and Druses), and may have preserved the memory of a Juventus Mundi, which lingered in their rocks, together with paganism and Ruskinian ideals.

The belief in the malign influence of the *mal-occhio*, or evil-eye, is

not confined to the Latin races, but prevails in Persia and China, as well as among the South-China Malays and their East Indian neighbors. In Southern Italy the superstition is almost universal. According to the popular theory, the possessor of an evil-eye can stare his victims into all sorts of afflictions, palsy, rickets, goitre, etc. Nay, his power for evil has hardly any limits whatever, for by the same optical process he can produce death and epidemics—cholera infantum, for instance. And, moreover, such persons are generally conscious of their dreadful talent, and can forbear its exercise, for they manage to connive at their favorites. Evil-eye wizards can be known by their peculiar way of squinting, or by their bushy eyebrows, that conceal the piercing steadiness of their gaze, and orthodox crones lament the decadence of the good old times when such offenders could be brought to justice. According to the myth of the Puranas, the god Siva can blight a whole town with his withering look; and the Indian gods, who often visit earth in the guise of mortals, are sometimes recognized by the *rigidness* of their gaze: they never wink; to their sleepless eyes space and time are units. Hecate and Medusa had such optics, and the basis of the superstition may possibly be the primitive man's dread of mental superiority, the power of mind over matter, ascribed to the eye, as the mirror of the soul. Captain Burton noticed that the negroes of Soodan are almost unable to meet a white man's gaze, though they quail still more before the fire-eyes of their Semitic neighbors. The Veddahs of Ceylon, too, seem, to dread a Siva in every foreigner.

But the most wide-spread of all superstitions is the belief in portents. In some of its modifications the tendency to ascribe an ominous significance to certain events, and good or bad luck to be auspices of certain times or contingencies, is all but universal. It survives the influence of every other form of superstition. The elder Pliny, who calmly rejects the entire mythological system of his countrymen, admits his belief in the prognostications of the haruspices. The skeptic, Wallenstein, kept two or three professional astrologers. Napoleon the Great was a firm believer in lucky and unlucky days. The Pyrrhonist, Walid, surrounded himself with Egyptian pages on account of the "favorable auspices of their nationality. The Marquis d'Argens, the presiding atheist of the Sans-Souci symposia, after shocking even the scoffing king and the king of scoffers by the profanity of his remarks, was apt to turn pale at the discovery of a double peach-stone or the accidental spilling of the salt. French mariners have ceased to vow wax-candles to Our Lady of Brest, but they still dislike to leave a harbor on Friday, or during the progress of a hail-shower. The agnostic Chinamen (for the gospel of Confucius is nothing but a secular code of morals) postpone a journey if they meet a decrepit old woman. Certain dreams impress them so strongly with the dread of impending disaster that even opium-smokers will forego their drug

for a day or two, in order to keep all their available wits about them. A Silesian miner will make his will if his lamp happens to go out before its oil is spent. According to the analysis of Immanuel Kant, the basis of the whole delusion is what he calls the *post hoc ergo propter hoc* fallacy—"after it, therefore because of it," or the tendency to mistake an accidental coincidence for the result of a causal connection. From this point of view there is no specific difference between a misapplication of the inductive method and the grossest portent-superstition. The precipitate follower of Bacon has noticed the coincidence of cold weather and catarrhs, and jumps to the conclusion that a low temperature deranges the functions of the respiratory organs; he has known cases of recovery following the use of Dr. Quack's cough-medicine, and ascribes the cure to the nostrum. The weather changes about four times a month, a month has four lunar phases, therefore the weather depends on the changes of the moon. At the roulette-table certain numbers may now and then turn up oftener than others: the gambler concludes that they must be lucky numbers, or bets on red cards because he twice lost his monthly salary on a black one. To the objection that the weather-superstition deals, after all, with fixed natural laws, and the roulette-superstition with capricious accidents, the gambler might reply that so-called accidents are only necessities in disguise.

When that disguise is practically impenetrable, the theoretical attempts to that effect speak, perhaps, in favor of an order-loving and systematic tendency of the human mind. Man is a methodical animal, and will regulate his conduct by the most fantastic rules rather than act entirely at hap-hazard. "In the game of life," says Edmond About, "men are often apt to follow a system where they might just as well play at random."

In some cases that tendency may be ascribed to a latent fetichism. In the age of faith every man had his favorite days, months, numbers, stars, colors, etc.; for all such things had their presiding deities, and their partisans, as it were, threw themselves upon the protection of a tutelary spirit. The hero of the "Cyropædia" never gives battle without sacrificing to the genius of the day and the nymphs of the surrounding rivers and mountains. Scipio Africanus used to invoke the deities of a hostile city before he brought his battering-rams into play, just as the Zooloo Caffres propitiate the demons of a new hunting-ground. It seemed the safer way—"If it does no good it can do no harm"—as the mediæval apologists justified the invocation of the patron saints, and in the same way a gambler may defend his "system" against the objections of his intellectual conscience.

The rules of such systems often suggest the influence of curious associations of ideas. In ancient Greece the luckiness of the first lunar phase was deemed so axiomatic that the Spartans missed the battle of Marathon rather than take the field before the new moon.

The two weeks preceding the *plenilunium* suggest the prime of life, when things in general progress favorably, while the subsequent half months correspond to the age of declining strength and general retrogression. The haruspices augured on the principle that a bird's flight from left to right was a favorable omen—things were going the *right* way, while by the laws of consistency the opposite direction suggested adverse tendencies. Birds, as creatures of the air, seemed the fittest messengers of the gods, who had a way of imparting their revelations by symbols, and might be supposed to choose the beginning of an unlucky enterprise as the best time for warning their favorites: When Conradin of Hohenstauffen set out for that fatal campaign that ended on the scaffold of Naples, his horse refused to cross the Arno Bridge, and an old citizen adjured him to turn back, but he dismounted and led his horse across. "It means that we are going to prevail *afoot*," he laughed, alluding to the preponderance of his infantry force. A year before the invasion of the Saracens, King Roderic saw their horses and riders in a dream; and Appolonius of Tyana foresaw even the great *aphanasia*, the fifteen hundred years' eclipse of common sense and reason. "Woe be to our children!" he exclaimed, on awakening from a trance; "I see a shadow approaching; a great darkness is going to cover this world."

After the analogy of great natural catastrophes, events of national importance were supposed to cast premonitory shadows, and in nearly every country on earth the myth-making faculty of the people has accordingly supplied a set of portents for every momentous incident of their history. Tacitus records a due number of obituary prodigies for every one of his Cæsars. The battle of Adrianople, where the clubs of the Visigoths broke the power of the Roman Empire, was foretold by an augur who had seen a portentous cloud approaching from the east in the teeth of a strong west wind. The conquest of Mexico was the fulfillment of an omen that had plainly warned the natives of their impending fate. In the night when Abderrahman el Hakim died, shooting-stars showered down as if they were going to set the earth afire. The tyrant Polycrates of Samos was born during an earthquake that shook the foundations of the island. Before the birth of Buddha Sakyamuni the Ganges flowed back to its source, flowers sprouted in desert places, a sound of music rung through the air, corpses left their tombs, and a new star appeared. A new star appeared also after the murder of Julius Cæsar, and certainly after the death of Antinous, for the Emperor Hadrian ordered it to be worshiped as the transfigured spirit of his favorite.

The *rationale* of the superior luckiness of odd numbers is less obvious, but they were certainly the favorite numbers of the Gnostics and of all mythological systems. The three Graces, three Fates, three Furies, three Judges of the dead, and three-headed hell-hounds appear as mystical as the Indian Trimurti and its derivatives. The seven

sacraments, seven gates of the New Zion, and seven golden candlesticks, correspond to the seven days of the week. Lars Porsenna swears by the nine gods, and Ovid by the nine Muses. All, perhaps, for the negative reason (though *oddity* may have its positive attractions) that a deliberative junta of even numbers can not get the benefit of a casting vote. Gamblers rarely bet on even numbers; it is one of their corporation maxims, besides which every individual player has a by-law code of his own. The Spaniard Garcia, who broke every gambling-hell on the Rhine, operated upon the theory that luck, like history, repeats itself in a certain succession, and kept a list of successive hits, in order to back the same series after the turning up of the first number. Count Esterhazy, whose portentous luck made him the bugbear of the Swiss watering-places, believed in the inspiration of a first attempt, and relied on the instinct of a pointer—any novice who in consideration of a percentage would consent to locate his stakes. That the tiger-wardens themselves are not above such superstitions seems proved by the fact that the managers of the little Bath Pfeffers once offered him ten thousand francs to dig his gold from a wealthier mine.

"*Fortis Fortuna adjuvat*" ("Fortune favors the *strong*") was a Latin proverb, and Napoleon, like Suvaroff and Bismarck, asserted that she is always on the side of the big battalions, though, like their fellow-men, they probably inclined to the private opinion that "luckiness" is a special faculty, and that, irrespective of their energy, prudence, and perseverance, some people manage to score success after success. In the California bonanza period every camp had its "lucky man," not always the best mineralogist, but a fellow who somehow had a knack of stumbling upon "pay-dirt," and thus became the chosen pioneer of his comrades. It sometimes really seems as if the race were neither to the swift nor the cunning. We have merchants, speculators, and politicians, whom Fortune declines to forsake, in spite of all their blunders—*Sontags-kinder*, "Sunday-children," as the Germans call them—fellows who have six points ahead in every game and beat the best players. Where others have wasted their time in mining and counter-mining, they take every fort at the first assault, and for no apparent reason, unless good luck begets self-confidence, for pluck is perhaps, after all, the secret of every real success.

The Chinese divide all auspices into *yan* and *yuen*, male and female, positive-lucky and negative-unlucky streams of tendency. The sun is a *yan*, the moon a *yuen*, luminary; daylight blesses and vivifies; moonlight blights. For cognate reasons, perhaps, Friday (the day of Friya, *dies Veneris*) is an unlucky day: among the Romans, as well as among the ancient Saxons, it was sacred to a *female* deity. M. Quetelet estimates that the Friday superstition costs the French railway companies an average aggregate of five million francs a year, by which sum the expenses of Friday passenger-trains exceed the receipts!

If we consider the expensiveness of the Delphian oracle and the Loretto miracle-factory, the sums wasted on all kinds of amulets, from a brickbat fetich to a marble cathedral, we must admit that superstitions are costly luxuries. Dome-building, the most expensive phase of the mania, culminated during the night of the middle ages, and that night is certainly passing away, but many of its specters still frequent their ancient haunts; for supernaturalism is a Proteus, and apt to assume shapes that can not be exorcised with daylight. Like the poison-habit, the thirst for miracles satisfies its craving with a variety of stimulants. Ex-Romanists revel in mysticism, as their ancestors fuddled with the Rosicrucian Gnostics, and afterward with magic and astrology. Protestants often yield to the craving for stronger stimulants and glut it with rectified spiritism, undiluted with traditions and homilies. Mr. Kiddle's apocalypse is the confession of a moral opium-eater. In France professional free-thinkers patronize not less professional clairvoyants; the pythoness Lenormand amassed a fortune of two million francs, and was consulted by atheists and philosophers, and twice even by the Emperor Napoleon, whose speculative dogmas were limited to a few negative tenets. German nonconformists are apt to contract a passion for ghost-stories. Their publishers have regular sample-rooms of supernaturalism; Arnim's novels, a rock-and-rye mixture of romantic poetry and spook stories, have become household works; Jung Stilling's *Geister-kunde* (Spectrology), a sort of proof-spirits with a flavor of pietism, has still an enormous circulation. Men who never enter a church, and treat all sects with the tolerance of absolute indifference, procure their tipple from a circulating library, like peace-loving topers who shun tavern-brawls, but now and then purchase a quart of rum and take it home in a pocket-flask. On the whole, it is a step in the right direction. Their liquor is often as strong as anything sold across the bar, but the effects of their inspiration are limited to the precincts of a private sanctum, and they are less apt to force their poison upon their neighbors.

[*Concluded.*]

## PERCEPTIONAL INSANITIES.*

By W. A. HAMMOND, M. D.

THE simplest forms of insanity are those which consist merely of false perceptions, and they are not of such a character as to lessen the responsibility of the individual. There are two forms of false

* Abridged from advance sheets of Dr. Hammond's forthcoming work on "Insanity in its Medical Relations."

perceptions—illusions and hallucinations. Uncomplicated illusions are rare; still there is no doubt that there are illusions not the results of disease in the organs of sense or of circumstances unfavorable to exact perception, but which are due to a morbid condition of the perceptional ganglia, and the unreal nature of which is clearly recognized by the individual.

Illusions of *sight* often relate merely to the size of objects. Thus, a young lady who had overtasked herself at school saw everything of enormous size at which she looked. The head of a person seemed to be several feet in diameter, and little children looked like giants. So far as her own person was concerned there were no illusions. Her own hands appeared of the natural size, but those of other people seemed to be of enormous proportions. Sauvages refers to a case in which a young woman, suffering from epilepsy, had the illusion of seeing objects greatly magnified. A fly seemed to her to be as large as a chicken. In the case which came under my observation, the unreal character of the perception was fully recognized, and hence the intellect was not involved.

Morbid illusions of *hearing*, unaccompanied by other evidences of mental derangement, are not very common. One case only has come under my observation. It was that of a gentleman to whom the ticking of a clock was resolved into articulate words. Generally the expressions were in the form of commands. For instance, if at dinner, they would be, "Eat your soup!" "Drink no wine!" and so on. One day he made the discovery that, if he closed the right ear firmly, the illusion disappeared; but, if the left ear were closed, the words were still distinctly heard. It was hence clear that the center for hearing on the right side was the one affected, and that that on the left side was normal. For a long time this gentleman resisted accepting any of these illusions as facts, but after a time he began to be influenced by them to the extent of regarding them as guides. Eventually he put clocks in every room in his house, and professed to be governed altogether by the directions they gave him.

Illusions of *touch*, as Michea says, may relate to temperature, movement, weight, and the character of surfaces. Thus, to some patients, substances that are hot feel cold, and *vice versa;* others feel the things on which they sit or lie glide from under them. Illusions of a general character as regards the whole body are quite common—giving the sensation of extreme weight or lightness, or as if the body were immensely lengthened or shortened.

As regards frequency, illusions of the sense of touch occupy the front rank; next are those of sight, and next those of hearing. Illusions of taste and of smell, except with persons who are otherwise insane, are not common. A few instances of the latter, however, have occurred within my personal experience. To one of these, a lady, everything she put into her mouth tasted like cauliflower; in another

instance, the flavor was that of strong Roquefort cheese, and in another of pears.

The difference between illusions and hallucinations can be recognized without difficulty, for the latter are entirely cerebral in origin, and do not require, as do the former, a material basis. They can not be produced by any defects or derangements of the sensory organs, or by any external circumstances tending to interfere with the normal action of these organs. We have to consider them now as resulting from disorder of the perceptional ganglia without the implication of those parts of the brain which are concerned in the production of intellect, emotion, or will.

The case of Nicolai, the German bookseller, is a striking instance of hallucinations of *sight*. For ten months he had been a good deal disturbed by several melancholy incidents. A customary blood-letting was omitted, and added to all was an unusual press of business matters. One morning he suddenly perceived, at apparently the distance of ten steps, a form like that of a deceased person. The phantom continued only for about ten minutes, but in the afternoon it reappeared. He arose and went to another room, the apparition accompanying him—disappearing, however, at intervals, and always maintaining the erect posture. Later there appeared other figures, unlike the first.

After the first day the figure of the deceased person no longer appeared, but its place was supplied by many other phantoms, sometimes representing acquaintances, but mostly strangers. After about four weeks he began to hear them talk. The application of leeches to the arms relieved him promptly of his hallucinations.

Hallucinations of *hearing* are more common than those of any other of the special senses, and, according to my experience, are more apt to lead to further mental disorder. Far more people kill themselves under the influence of hallucinations of hearing than from those of all the other senses combined. The reiteration in the ears, during every minute of the day, of the command to jump into the river, to plunge a convenient knife into the heart, and so on, day in and day out, is calculated to shake the power of control of the strongest-minded.

Sometimes a single word or a few words constitute the hallucination, but in their more complex character they are sentences and even long discourses. No instance that has come under my observation equals that of a lady who hears recited to her long pieces of original poetry or prose. She has repeatedly written down these recitations and brought them to me. This lady had a strong hereditary tendency to insanity, and, shortly after the development of the hallucinations referred to, she imbibed the delusion that she had committed the "unpardonable sin." She made two attempts at suicide, and is still insane, but has—an unusual circumstance—lost the delu-

sion of the "unpardonable sin," and contracted the idea that she has no bowels.

As hallucinations of sight often exist while the eyes are closed, or in persons who are totally blind, so hallucinations of hearing continue though the ears be stopped, or originate in persons who are entirely deaf. A deaf-mute who came to my clinique at the University Medical College was constantly subject to hallucinations of hearing. It is said that in the last years of his life Beethoven became completely deaf, but that he heard his compositions as distinctly as when he actually listened to them when performed by an orchestra.

Hallucinations of hearing, like those of sight, are sometimes unilateral—that is, heard by only one ear. Baillarger cites several examples of the kind.

Calmet gives some interesting details relative to hallucinations. In one case a M. de S—— entered his study one afternoon, and, turning toward the door to go to his bedroom again, was much surprised to see it shut and barricade itself with the two bolts that belonged to it. At the same time the doors of a large press opened behind him and rather darkened his study, because the window which was open was behind these doors. "At this sight the fright of M. de S—— is more easy to imagine than to describe; however, he had sufficient calmness left to hear, in his left ear, a distinct voice, which spoke to him in very good terms, and ordered him to do some one particular thing which he was commanded to keep secret."

Hallucinations of *smell*, though not so common as those of sight and hearing, are yet often met with. A gentleman of my acquaintance was almost constantly subject to the hallucination of smelling paint or turpentine; another had the odor of coffee ever present in his nostrils; and another, a physician, was always annoyed with the smell of the dissecting-room. It is well known that some epileptic seizures are preceded by the sensation of a horrible stench.

Hallucinations of *taste* are not common. Indeed, it is sometimes difficult to say whether they exist or not, as various visceral irregularities may cause the production of tastes by modifications impressed upon the saliva. Mental excitement will cause a like effect in some persons. I am acquainted with a gentleman who can not participate in any engrossing conversation without having a bitter taste developed in his mouth.

Hallucinations of the sense of *touch* are, on the other hand, very frequently met with. Sensations apparently not based on any real impression are experienced in various parts of the body. It is difficult, however, to discriminate between illusions and hallucinations of touch.

Occasionally persons have the power of voluntarily producing hallucinations. A practice fraught with danger, for the time is apt to come at which they can not get rid of their false perceptions. As an

instance, I cite the following case from Wigan. The painter referred to is Blake:

"A painter, who inherited much of the patronage of Sir Joshua Reynolds, was so fully engaged that he told me he had painted three hundred large and small portraits in one year. The fact appeared physically impossible, but the secret of his astonishing success was this: he required but one sitting of his model. I begged him to detail to me his method of procedure, and he related what follows: 'When a sitter came, I looked attentively on him for half an hour, sketching from time to time on the canvas. I removed the canvas and passed to another person. When I wished to continue the first portrait I recalled the man to my mind, and placed him on the chair. Then I went on painting, occasionally stopping to examine the posture, as though the original were before me. This method made me very popular, for the sitters were delighted that I spared them the annoying sittings of other painters. 'By degrees I began to lose all distinction between the imaginary and the real figure; then all became confusion. I lost my reason, and remained for thirty years in an asylum.'"

It is related of Talma, the great actor, that he could cause the audience to appear to him like skeletons, and that, when the hallucination was complete, his histrionic genius was at its height.

Goethe states that he had the power of giving form to the images passing before his mind, and, upon one occasion, saw his own figure approaching him.

Several like cases have come under my own observation. In one, the power was directly the result of attendance at spiritual meetings, and of the efforts made to become a good "medium." The patient, a lady, at first thought very deeply of some particular person, whose image she endeavored to form in her mind. Then she assumed that the person was really present, and addressed conversation to him. At this period she was not deceived, for she clearly recognized the fact that the image was not present.

One day, however, she was thinking very intently of her mother, and, happening to raise her eyes, she saw her mother standing before her exactly as she had imagined her. In a few moments the phantom disappeared, but she soon found that she had the ability to recall it at will. During the spiritualistic meetings she attended, she could thus reproduce the image of any person upon whom she strongly concentrated her thoughts, and was for a long time sincere in her belief that they were real appearances. At last she lost control of the operations, and became constantly subject to hallucinations of sight and hearing.

Although no one presumes to question the honesty of Jerome Cardan, or of Swedenborg, it is probable that their visions were also induced by intense mental concentration. In some persons very slight thought is sufficient to cause hallucinations of great distinctness.

The causes of central illusions and hallucinations are generally to be found in derangements of some kind in the blood circulating in the brain. These may either relate to its quantity or its quality.

Physical influences calculated to produce cerebral hyperæmia or congestion may give rise to illusions or hallucinations. Brierre de Boismont refers to a case, on the authority of Moreau, in which an individual was able to obtain hallucinations of sight by inclining his head a little forward. A similar case was not long since under my own care. A gentleman, while sitting at his table writing, happened to raise his eyes without moving his head, and saw before him the figure of an old woman with black cloak and hood. Throwing himself back in his chair in his amazement, he found that the image slowly disappeared; and, as often as he repeated these movements, a like series of phenomena occurred. On examining him, I found that he wore a very high, old-fashioned stock, which, as he sat at the table with his head bent forward, compressed the large veins of the neck, and prevented for a time the return of blood from the brain. On changing his neck-wear for other of more modern fashion, he was enabled to bend his head and raise his eyes without encountering the apparition.

A gentleman once consulted me who, for several weeks, had seen, just as he lay down, the figure of a very old man, who stood by the side of his bed grinning and beckoning to him. At first he was deceived, and started suddenly from his bed, whereupon his visitor disappeared. He made several tests which satisfied him as to the real character of the phantom, and then, like a sensible man, tried to get to sleep, but in this attempt he succeeded badly.

The explanation of such cases is very simple. The recumbent posture facilitates the flow of blood to the brain, and at the same time tends, in a measure, to retard its exit. Hence the appearances were due to the resulting congestion. As soon as the individual rose in bed, or stood erect, the reverse conditions existed, the congestion disappeared, and the apparition went with it.

The influence of cerebral *hyperæmia* in causing hallucinations seems to be clearly established. Ferriar wrote a treatise with the special object of proving that this is the only cause. This is an extreme view, however, which can not be sustained, for that the very opposite condition, cerebral *anæmia*, is an immediate cause of hallucinations is seen in the facts that, during starvation and other conditions producing great bodily exhaustion, hallucinations are common occurrences.

A striking instance has recently come under my observation, which shows, undoubtedly, that a reduction in the amount of blood circulating within the cranium may give rise to hallucinations. A young woman affected with epilepsy had repeated seizures while in my consulting-room, and, with a view of arresting them, I exerted strong pressure on both carotid arteries. Her face instantly became pale,

and, without losing consciousness, she uttered a loud shriek, and pointed at an object which she apparently saw near her. I at once discontinued the pressure, when she informed me that she had seen an immense negro rushing toward her with a club, and that as soon as I had stopped pressing on her neck the figure had disappeared. I assured her it was an hallucination, and induced her to let me repeat the experiment. I now exerted moderate pressure, with the view of keeping it up for some little time. In about half a minute she said that she saw the figure, but not very distinctly, and I found that I could make the figure appear distinct or indistinct by varying the degree of pressure.

Children are very liable to be subject to hallucinations, and frequently give circumstantial accounts of incidents which they believe have occurred to them, of voices they have heard, etc. It is often impossible for them to discriminate between the true and the false, and I am afraid they are often punished for lying by ignorant parents, when they have told nothing but what they have had the evidence of their senses for believing.

A great deal has been written relative to the physiology of hallucinations, but without much result so far as any explanation of the process is concerned. There is some evidence to show that the *thalami optici* are the centers for all real perceptions, and that hence they are the organs, which, through their disease, give rise to all centric illusions and hallucinations. Luys more than any other physiologist has elaborated this idea, and has adduced arguments in its support which it is difficult to overlook. His doctrine is that the optic thalami are reservoirs for all sensorial impressions coming from the periphery of the nervous system, and that, like other ganglionic masses, they elaborate these impressions, and that, by means of the fibers of the corona radiata, they transmit them to the cortex, to be still further perpetuated by being converted into ideas.

If there is no organ of sense, there can be no normal sensorial impression; if the optic nerve be divided, the sensation can not be transmitted to the optic thalamus; if there be a diseased optic thalamus, the sensorial impression will be perverted and there will be an illusion of centric origin; if the cortex be in a normal condition, this illusion will be corrected and understood as such erroneous perception; if, however, the cortex be diseased, the illusion will be accepted as true, and a false idea, or delusion, will be formed. Such an impression formed in the optic thalamus is an hallucination, and will be accepted for reality or not according as the cortex is healthy or diseased.

Such is, I think, the pathology of perceptional insanity. The lesions of the optic thalamus necessary to the production of a false sensorial impression may be of varied character. Congestion is probably that which most commonly exists, especially in the early stages, and in those cases which are not accompanied by derangements of the other

categories of mental faculties. Anæmia is likewise a condition of frequent occurrence. At later periods, as Luys says, the optic thalami are the seats of degenerations which show that there have been frequent perturbations of the circulation. He is very strong in his conviction that there are secondary changes, which are the cause of the transformation of psycho-sensorial hallucinations into those which Baillarger designated psychic. In my opinion, they are the cause of the hallucination becoming a delusion, and, indeed, between a psychic hallucination and a delusion there is very little difference. The former can not exist without the involvement of the intellect.

## DWARFS AND GIANTS.*

By M. DELBŒUF.

A BELGIAN philosopher, M. Stas, declared, two years ago, that "no science to which measure, weight, and calculation are not applicable can be considered an exact science; it is only a mass of unconnected observations, or of simple mental conceptions." I agree to this without reserve. Undoubtedly, vain imaginations and crude theories, which have form without solidity, should be banished from science; but it does not follow that we must define science as a collection of weights and measures, and calculations upon them, or as consisting of combinations of algebraic formulas from which other formulas may be deduced. These matters of weight, measure, and calculation must have some synthesis or useful purpose in view. They should throw light upon some law, and that a law which is an idea, or which is susceptible of being converted into an idea. It is the philosophic thought penetrating them that gives interest to the statistical labors of Quetelet. The cry of the positivists of the day is for "facts!" To that I oppose another cry: "Ideas! give us ideas!" A fact without an idea is a body without a soul, a useless incumbrance to the memory. I come to the defense of speculation. While I view with impatience volumes of figures, operations, and formulas, of which the signification and bearing can not be perceived, I am inclined to be grateful to the man who throws out a new idea, though it be a thousand times false. There is always more to be learned from the thinker who talks nonsense logically than from the observer who does not reason at all. From nothing, nothing can come, but error may bring forth the truth at the price of its own death.

Laying aside these generalities, let us consider an example of the

* From an address before the Royal Academy of Belgium. Translated for "The Popular Science Monthly."

way in which we can weigh and measure, submit the results to calculation, and draw from them conclusions which are formally quite legitimate, and still be all the time on the wrong track; then examine how we may be set upon the right road, and led to a new conclusion more plausible and more in harmony with the rest of our knowledge.

It has been discovered that the flea can leap two hundred times its length. Our admiration at this is changed to astonishment when it is demonstrated by calculation that, if nature had endowed the horse with a degree of strength similarly proportioned to his weight he would have been able to clear the Rocky Mountains at a bound, and that with a like effort a whale would be able to leap to a height of two hundred leagues. What can be more unassailable than these conclusions, founded on weight, measure, and calculation?

It is true that, if, instead of comparing the weights of the horse and the flea, we had compared their heights, we should have found that the horse's leap would not measure more than three hundred metres. Why is preference given to the weight? Because it is its whole body with its three dimensions and its density that the flea hurls to two hundred times its height, and it is the same feat of strength that we demand in vain of the horse. Calculations have also been made to show that, if a man could move with a speed proportioned to that of certain insects, he would be able to travel more than ten leagues in a minute, or sixty times as fast as a railroad-train.

The Amazon ants, going to battle, travel from two to two and a half metres a minute. The Amazons of antiquity, to be even with them, if we judge by the relative heights, should have traveled eight leagues an hour. We have, however, in this case, to compare the forces with which given masses move themselves, and should take account of weights or volumes. If we proceed by this rule, we shall obtain formidable numbers, that stagger the boldest imagination. The warlike inhabitants of the banks of the Thermodon would have to get over fifty thousand leagues in an hour. Yet, who can deny the truth of the observations, the rigor of the measurements, or the justice of the reasoning?

The authors of these interesting calculations have not had in mind only to make known some figures of comparison, good to store up, even if they are never used, but they have endeavored to set forth the idea that certain insects are much better endowed with powers of leaping and speed than the vertebrates, and especially than man. The persons who express this conclusion have failed to conform to the precept that they must not extract more from their facts than is rigorously contained in them, and are the victims of a scientific illusion, which is quite wide-spread, but not hard to dissipate. What is in question? It is the valuation of the labor necessary to raise a certain weight to a certain height. The labor increases in proportion to the weight and the height. When, then, two animals of different masses leap to

the same absolute height, each one performs a work precisely proportional to its mass ; and, when a man leaps over an obstacle sixty centimetres from the ground, he accomplishes, other conditions being the same, a task as considerable again as that of the flea or the grasshopper, which can not spring much above thirty centimetres.

A few figures will make the matter plain. Take a grasshopper weighing six decigrammes (nine grains), and a man weighing sixty kilogrammes (one hundred and fifty pounds). The man is equivalent in weight to a hundred thousand grasshoppers. But a hundred thousand grasshoppers grouped into a single mass could only raise that mass thirty centimetres, while the man can lift his own mass sixty centimetres. All the advantage, then, is on the side of the man. Here is a wide variance from the strength which has been exacted of the horse to make him a rival of the flea.

The basis of the comparison was vicious. The height or volume of the agent who handles a weight has nothing to do with the estimation of the labor. A sack of meal is no heavier on the shoulders of a man than on the loins of a horse. The labor and the effort have been confounded. The labor is a defined and absolute quantity ; the effort a vague and variable sensation.

The deductions respecting speed have no better foundation. The ant, as a moving body, is a little mass of matter on which a determined force impresses a speed of two and a half metres a minute. To impress the same speed on a mass of fifteen millions of ants—which I take to represent the volume of a man—would require a force fifteen millions greater. This force is developed by a man going two and a half metres a minute, while in the same space of time he can easily accomplish a hundred metres and more. In this case, then, if we take notice of any one of the data, the man manifests a strength forty times greater in proportion than that of the ant. This is a very different result from the one arrived at by the other method. Other data, however, come in to complicate the comparison and considerably modify the result.

A little closer study of the phenomena of walking will show us that it absorbs a considerable quantity of force that does not appear in speed. It is not simply a uniform transportation of the body along an horizontal line ; but at each step the body is raised, and falls again. The incessant repetition of the lifting is a great cause of fatigue. Hence, walking on an uneven road tires us greatly. In the best paths, the differences of level which have to be overcome correspond with a notable quantity of force lost from speed. The ant, however, being a creeping thing, and supported on six feet, has to raise only a very small part of its weight at each step, and is therefore more advantageously formed than the man, who, having only two feet, gives to his whole body a double oscillation—sidewise, and up and down. On the other hand, the ant feels even the slightest inequalities of the ground. When it goes over the space that represents a man's step, and requires

only a single lifting of his body, it has to lift its own perhaps a thousand times. The sum of all these little lifts would probably give us a considerable one.

The conclusion we have just reached, that man is relatively forty times stronger than the ant, deserves, then, a closer examination; and it may be that the just interpretation of our facts will cause us to believe that the energetic capacity of muscular fibers is nearly uniform in all animals.

There is another illusion in these matters, which we might call psychological. The agility of some animals surprises us. The monad in a drop of water moves so nimbly that we can hardly follow it; and we naturally make a comparison between the distance which an animal can cover in a certain time and its dimensions. The reasoning of this comparison presents a problem somewhat difficult of solution. It is enough to know that we can not draw from the illusion the consequences which we like to see in it.

If I were to attempt an explanation of this agility, which gives small animals so great facility in escaping their enemies, I should look for it in the small momentum of their mass when in flight, by reason of which only a slight effort is required to enable them to change their direction. Incontestably, we can run much faster than mice; nevertheless, it is not easy to catch a mouse in a closed room. Our own mass is an impediment to our agility. By the time we have made a spring in one direction, the mouse has changed his, and we put our hand, too late, where he was. It is very hard even to lay hold of a bird in a narrow cage.

The part of our question that remains to be treated is no less arduous or obscure than that which we have gone over. I will try to throw what light is possible upon it, but I can not flatter myself that I shall fully succeed. M. Plateau some seventeen years ago measured, with the aid of ingenious harnessings and other devices, the muscular force of insects. He deduced from his experiments that, aside from the power of flight, insects have, as compared with vertebrates, an enormous strength in proportion to their weight; and that in the same group of insects the strength varies, as between different species, inversely as the weight, or, in other words, that the smallest insects are the strongest.

Some of his single results were really surprising. While a horse weighing six hundred kilogrammes can hardly support four hundred kilogrammes, or two thirds of his weight, he found May-bugs, weighing a sixth of a gramme, able to support sixty-six times their own weight, or more than ten grammes. Here, then, was a humble and stupid beetle a hundred times as strong in proportion as the proud and sturdy horse. Another little insect, weighing half a decigramme could move a hundred times its weight. By this standard we men ought to be able to struggle with weights of six thousand kilogrammes

(or fifteen thousand pounds), and elephants should move mountains. We can not dispute the accuracy of the experiments or the calculations, nor impeach the sincerity or judgment of the experimenter. The facts are, moreover, conformable to observations. A caterpillar in the closed hand will make prodigious efforts to open his prison; and who has not seen ants carrying things three or four times as large as themselves? Various attempts have been made to escape the consequences that were deduced from these experiments, but they still stand, apparently defying criticism. Must we, then, resign ourselves to being a hundred or two hundred times weaker than a beetle? Are insects really, in physical force, kings of creation?

Not yet. An important element has been neglected. No account has been made yet of the time it takes the insect to perform its wonderful feat. Whenever we raise a given weight to any height, by whatever method, the labor performed is in proportion to the weight multiplied by the height; and this product always gives the measure of that labor. The same product, under certain restrictions, furnishes the measure of the force that is utilized in the work. A dog is not as strong as a horse, but both animals expend precisely the same force in raising a kilogramme a metre. Whatever the kind of work he may wish to calculate, even though it be horizontal, it is always reducible to the elevation of a certain weight to a certain height, and is in practice measured by a formula of which these are the terms.

While, however, the quantity of force that must be expended for a determined work is invariable, this is not the case with the manner in which that expenditure may be distributed. If I wish to strike a single strong blow, I execute a quick movement. If my muscular power is weak, I must have more time. It is possible, then, for time to supply a deficiency of power. I can make such a substitution applicable in two ways, by dividing the resistance, or by using a machine as a lever, which, when everything about it is considered, is nothing more or less than a device by means of which we replace power with time.

Accurately to compare the strength of a May-bug with that of a man, we must take into the account the time which the insect requires to perform the work exacted of it. Suppose a horse harnessed to a load of half his weight, and a May-bug drawing a tray fifty times as heavy as itself: the beetle's load will be relatively a hundred times as heavy as the horse's. But if the horse needs only a second to raise his load a metre, while the insect takes a hundred times as long to produce the same effect, then the efforts of which they are both capable are proportionably the same. The case is the same, only the appearance is changed, when the force is spent in maintaining the weight at an equilibrium.

In a similar manner we may account for the power manifested by the insect which I cover with a board a hundred times as heavy as itself, and which gets its head under the edge, raises it, and escapes

You know that, if we should put a horse under a bell weighing sixty thousand kilogrammes, it could not make its cover move at all. That is because the animal can not insinuate itself under the edge of the bell, and is not formed to raise weights with its head. But fix a lever under the edge so that the horse can work conveniently at its longer arm, and require him to raise the weight, not to a proportionate, but to an equal height with that to which the insect raised his board in the same time, and he would not fail to achieve the task.

The interest of the problem before us does not lie simply in learning why insects are capable of efforts which appear enormous as compared with their size. The important thing is to discover whether Nature, as has been said, has regarded them more favorably than it has the vertebrates and man, and has endued them prodigally with muscular force, while it has been parsimonious to the other animals. We need not believe anything of this kind. The prodigies of force that astonish us are due to a very simple cause, and can be accounted for under the common law that, of two muscles having the same mass and the same energy, the shorter one is capable of raising the more considerable weight. We may figure muscular fiber as a spiral spring, habitually relaxed, which, under nervous action, flies back upon itself. Suppose this fiber to be a decimetre long and capable of contracting to half its length, and that it has attached to it a weight, say, of a centigramme. Under the nervous action, it will raise this weight half its length, or five centimetres. Now, if we replace this single fiber, a decimetre long, by a muscular bundle weighing just as much but composed of ten fibers a centimetre long, we can attach a centigramme weight to each of these fibers, or ten centigrammes to the whole bundle; but the weight will be raised, under the contraction of the muscle, only five millimetres instead of five centimetres. What we have gained in power we have lost in extent of motion. That is the rule. We have hence a right to conclude, that short muscles have the peculiarity, as compared with long muscles of the same volume, that they act more slowly but can move more considerable masses. Consequently, small animals perform, absolutely, slower motions, but, in compensation they can move proportionately heavier masses. We can thus comprehend how our insect can move masses a hundred times heavier than itself, without having to infer that it is a hundred times stronger than a horse. Introducing its head and corselet under the obstacle it desires to remove, it stretches its six legs, raises its body, and develops an apparently surprising force. Really, it has lifted the obstacle only in the slightest degree, but enough to allow it to escape. Its strength has been furnished by the short and thick muscles of its six legs and its neck. These considerations furnish the key to all the Herculean labors performed by small animals. The smaller the animal, the more capable it is of great efforts; only it loses in speed what it develops in force. Hence the strongest insects are generally the slowest.

Let us finish our argument with an imaginary illustration embodying the principles and the consequences derived from them. An adventurous explorer, visiting the countries in which Gulliver traveled, brings back a Lilliputian and a Brobdingnagian. The giant is thirty feet high, the dwarf four inches. Since one is about a hundred times as large as the other, their respective masses, and consequently the masses of their muscles, must be in the proportion of a million to one. If a common man weighs sixty kilogrammes, or 150 pounds, the Brobdingnagian should weigh 15,000 kilogrammes, or about 38,000 pounds, and the Lilliputian only fifteen grammes. They agree to compete with each other in the gymnasium. At the pulleys, the Brobdingnagian can easily raise a weight of 10,000 kilogrammes, or 2,500 pounds, as high as his shoulders. Looking to the Lilliputian, we would at first sight not expect him to be able to raise more than ten grammes to his shoulders. He really proves able to lift a hundred times as much, or one kilogramme, or the equivalent of seventy-five times his weight. This is because the distance to his shoulders is a hundred times less than the distance to his rival's shoulders, and he is able to apply against the weight the advantage which he derives from the relative shortness of the distance.

They next try leaping at the bar. The Lilliputian gracefully clears the pole at a metre from the ground. Will the Brobdingnagian be able to make a bound of a hundred metres? Not at all. He can hardly clear the bar at five or six metres. This is not because he is lacking in suppleness. Compare his mass with that of his little rival, consider that he has raised the center of gravity of that mass to the height of about a metre as the other has done with that of his inferior mass, and it will not be hard to do justice to his agility.

They are next started on a foot-race. A course of a thousand metres is laid out. The Brobdingnagian runs it in five minutes by steps of four metres each per second. The Lilliputian's steps are only four centimetres each, but he makes a hundred of them in a second; so he likewise goes over the track in five minutes. You give all praise to the Lilliputian, but do an injustice to his competitor. Think of what the giant has to do to move his legs! They are a million times as heavy as the Lilliputian's. But while he may have a million fibers, or a thousand in the diameter of a transverse section, the Lilliputian will have ten fibers in the corresponding diameter, or a thousand in all. Thus, while the masses are in the proportion of a million to one, the proportion as to the motive fibers is a million to a hundred. The Lilliputian, then, has the advantage. It may be objected that a hundred steps can hardly be made in a second. The objection is, however, only specious, for the wings of insects show us what is possible in this matter.

We are authorized by the aid of these illustrations to draw the important conclusion that the minute world is not, and can not be, in all

respects a proportional reduction of a larger world. There is an impossibility in the matter which I can only indicate, but which depends on the constitution of time and space.

If the views I have expressed are true, we have a right to infer that all animals as to their energy stand upon the same line, or, in other words, that a muscular fiber possesses the same properties, whether it belong to a vertebrate, an articulate, or a mollusk. Such a conclusion is more satisfactory at the first view than those which I have criticised, for our mind is fond of discovering unity and uniformity in nature. I am not certain that it is exact. That can be determined only by experiments. The question is now put into the hands of investigators who are endowed with the genius for patient and minute researches. Let them attack it with their instruments of observation and precision. The arguments they will deduce will be those before which we shall be forced to bow.

The main object of my remarks has been, however, to plead the cause, which in these days has been somewhat compromised, of Speculation, the mother of ideas, which allures us more frequently than it instructs us, but which stimulates, guides, and pushes us forward, and sometimes gives us a glimpse, if it does not permit us to contemplate them, of brilliant and grand horizons.

## THE CENSUS AND THE FORESTS.

By N. H. EGLESTON.

THE prudent and thrifty tradesman once a year takes an account of stock, and thereby assures himself as to what goods he has in possession, as well as what gain or loss may have accrued to him as the result of the year's transactions. So the nation, or, if we please to use the figure of personality, "Uncle Sam," deems it wise occasionally to take an account of stock; only this is done but once in ten years, and is called "taking the census." It could not well be taken oftener. The process is too long and too complicated. The reduction to tabular form of the millions of facts and items of information, the summarization of the particulars gathered from so many States and Territories, require no small amount of time, even with the best arrangements for facilitating the performance of the work. The results of the census of 1880 are not yet officially before us. Some facts as to population, the gross number of people in a certain range of cities and towns, and a few other facts of special interest or importance, have been communicated to the newspapers, and thus have become known to the public. But not a single volume of the thirty which the census report is expected to make has yet appeared.

Nor if we could have a more frequent census would it, perhaps, be desirable. We should not have time to become acquainted with the facts ascertained by one census, and to see their bearing upon our life and present occupations, before another census would be at our door with its claims upon our attention, because possibly necessitating some important change in our plans or pursuits.

With the growth of the country, the census constantly becomes a greater and more complicated matter. It was a comparatively simple affair at first. It was little more than the enumeration of the population of the country, for the purpose of apportioning direct taxes in the several States, and also the representatives in the national Congress. For the latter purpose the respective numbers of whites and blacks were given, three fifths of the latter being counted, during the existence of slavery, in determining the quota of representation for each State.

A noticeable fact in regard to the census of the United States is, that it is the result of a constitutional ordinance, the very first article of the Constitution providing for a general enumeration of the population within three years from the convening of the first session of Congress, and again during every subsequent decade. The first census was consequently taken in 1790. It gave the names of heads of families, the number of free white males above and below sixteen years of age, the number of females, and the number of slaves. Subsequent censuses have extended the classification so as to give the number of persons of any specified age, from one year upward to a hundred, and in recent years various other particulars. In 1810 the marshals were directed for the first time to make returns of the manufactures and manufacturing establishments of the country. So, from time to time, the census reports have embraced new facts in regard to the people and the products of their industry.

The ninth census, that of 1870, was much more full in this respect than any that preceded it. It gave not only the numbers of the people of all ages and the sexes, but their occupations and the products of their industries, as they had never been given before. Perhaps no country had ever had its material and social condition, its resources and productions, so fully presented to view as were ours by this census. With the experience gained in its compilation, and the satisfaction which its fullness had given, the census of 1880 was undertaken with the design to make it still more full and complete. Among other subjects to which special attention has been given in taking the tenth census is that of our forests. Hitherto the forests have been looked upon chiefly as the source of lumber-supply, and the census has taken account of them only so far as to report the statistics of the lumber-trade, and some of the industries connected with it or derivable from it. But the importance of the forests at once appears when we consider that the census of 1870 reported the annual value of sawed

lumber produced by our forests as $210,159,327, and that there were 63,928 establishments engaged in the manufacture of articles made entirely of wood, besides 109,512 establishments in which wood is an important part of the material used—as in the manufacture of carriages, agricultural implements, etc. It has been estimated that the value of the products annually drawn from our forests exceeds $1,000,000,000, and of the vast imports of Great Britain two thirds are said to be of vegetable character. Such facts show at once the very prominent place which the forests of the world hold among national interests. But, in addition to the bearing of the forests upon the mechanical industries of life, they have an important relation to climate and to the meteorologic conditions on which agriculture and commerce and the health and life of the people depend. When all these things are taken into account, as until recently they have not been, it becomes at once apparent that no subject, perhaps, deserves more consideration among the resources of a country, and that the special attention given it in the compilation of the present census is abundantly warranted.

Accordingly, the endeavor has been made to ascertain, with more completeness and precision than ever before, the situation of the country in respect to its woody covering; to learn to what extent the several States and Territories abound in trees in masses; of what species of trees the forests are composed, their location, and their commercial and industrial value. The work of ascertaining these facts, and presenting them in proper form as a part of the census returns, was committed by the Department of the Interior to Professor C. S. Sargent, of Harvard University, who is also manager of the Arnold Arboretum at Brookline. In carrying out the work assigned to him, Professor Sargent divided the whole country into several districts, each of which was given in charge to one or two competent persons, with the needful assistants, for the purpose of making a personal examination of the districts, and also ascertaining facts by correspondence with residents of different parts of the districts, so that a sufficiently exact report might be made in regard to the timber-growth of the country. Professor Sargent personally undertook the exploration of the Pacific division, including California, Oregon, and Washington Territory.

The result of this forest survey will be to give us a knowledge of the species and varieties of trees indigenous to our country, with the districts where they most abound, and where they attain their best development. It will show us what our forest resources are, whether for the production of lumber, or fuel, or for ornamental planting. It will show how far and how fast our forest supplies are diminishing, and from what cause or causes; whether from the axe of the lumberman, estimating the forests according to the number of feet of boards or timber which they will yield, or from the axe of the woodman or the miner; whether from the fire kindled by the pioneer, eager in the

quickest way possible to clear a space in which to cultivate his wheat and corn, and pasture his herds, or from the fire lighted recklessly or by accident by some passing huntsman or traveler.

In showing the relative position of our forests in respect to land elevation and the vicinity of streams, the census report will show the relation of the forests to the water-supply, and consequently their influence upon agriculture and manufactures. It will indicate their influence upon rain-fall and climate, as well as upon the course and effect of winds, whether considered in their mechanical or their meteorological relations. It will have an important use also as indicating the relative healthfulness of different portions of our wide and diversified domain.

In prosecuting his study of our forests, Professor Sargent has gathered a large collection of specimens of the different woods. These will show the natural appearance of the trees, and the variation of appearance and texture caused by growth under differing circumstances of soil and climate. From these specimens portions have also been taken and carefully worked down so as to show the grain and the susceptibility to polish, and their consequent value for mechanical and artistic purposes. The beauty of our native woods, and their adaptation on this account to the manufacture of cabinet-work, and to the interior finish of dwellings, will be made to appear as never before, and will be a surprise to many. It will be seen that we have gone abroad and procured materials for cabinet and carpentry uses at great expense when our own forests stood ready to supply all that the most fastidious taste could require. Professor Brewer, of Yale College, reports that there are probably 800 species of woody plants indigenous to the United States, of which 250 attain a height of thirty feet, and are abundant in some portion of the country.

Careful experiments have also been made in order to determine the relative value of our woods for the purposes of construction and for use as fuel. Blocks and sections of a great variety of trees have been selected, reduced to the same dimensions, freed to an equal extent from moisture—in other words, brought, so far as possible, to the same conditions—and then subjected to treatment at the United States Arsenal at Watertown, by means of nice and powerful machinery, in the hands of careful manipulators, for the purpose of determining the respective amounts of resistance to a crushing and a fracturing strain.

Similar pieces have also been burned, under like circumstances, as nearly as possible, and the amount of heat developed by their combustion accurately determined. The relative value as fuel of the different kinds of wood with which our country abounds has thus been ascertained. Probably no more trustworthy and decisive experiments have ever been made for the purpose of showing the value of different woods for the uses of construction or as sources of heat.

One of the peculiar and, practically, most valuable features of the

census report of our forest resources is the attempt made by Professor Sargent to give at a glance, by means of maps, the history and present condition of our woodlands throughout the country. In the census of 1870 maps had been used for the purpose of showing the distribution of our native and foreign population, the greater or less degree of illiteracy in different portions of the country, and the areas of land devoted to the cultivation of the great staples, corn, wheat, and tobacco. The vital statistics were also, to some extent, reduced to the map form, and the deaths from consumption, fevers, and some other classes of diseases were presented in the same way.

In the census report now in preparation this plan of presenting classes of facts at once through the eye by means of maps is applied to the woody covering of the country. More especially, the object has been to show the present extent of the supply of pine-timber, as being of chief importance in connection with the lumber industry of the country, and so bearing, more or less directly, upon many other interests and occupations. The hard-woods, also, where prevalent to any considerable extent, are of course denoted on the maps. Otherwise, their amount and localities are briefly described in the accompanying text of the report.

In general, one map is devoted to each State or Territory, though in the case of Vermont and New Hampshire the two are grouped together. The maps are carefully prepared, and the engraving and printing in colors are such that the eye perceives at once in what portion of any State or Territory the supply of pine is undiminished, and where and to what extent it has been cut off. It is also made apparent at once where the pine has exclusive possession of the soil, and where it grows mingled with the hard-woods.

In connection with the maps, but on a separate page, the statistics in regard to the lumber-supply are given in properly arranged tables, these with the corresponding map constituting a "Forestry Bulletin." The first of the Bulletins to be printed was that relating to the "Pine Supply of Texas," and a brief description of this will show the method pursued in all. The map of Texas is on a scale of one hundred miles to the inch. The water-courses are given with great completeness, and the county lines as far west as the one hundredth parallel. The map is so printed in colors as to show the parts of the State abounding respectively in the short-leaved or loblolly pine (*Pinus tæda*) mixed with the oak and other hard-woods; second, those abounding in the short-leaved or yellow pine (*Pinus mitis*), mixed with oak and other hard-woods, together with a little loblolly pine; third, those abounding in the long-leaved pine (*Pinus Australis*), and, fourth, the regions from which merchantable pine has been cut off. A glance at the map shows that Texas is poorly supplied with pine-timber, the entire State, with the exception of the few eastern counties, being uncolored, which indicates the absence of trees in any such numbers

as to constitute a forest. It is evident also from the map that in ten or twelve counties there is a considerable growth of the long-leaved pine, and in perhaps twenty or twenty-five counties a good deal of the two species of the short-leaved pine mingled with various hard-woods. But in seven eighths of the State there is not sufficient pine to be indicated at all on the map.

Turning now to the statistical tables accompanying the map, we find the estimated amount of merchantable pine standing at the date May 31, 1880, was as follows: long-leaved pine (*Pinus Australis*), 20,508,200,000 feet, board-measure; short-leaved pine (*Pinus mitis*), 26,093,200,000 feet; loblolly pine (*Pinus tæda*), 20,907,100,000 feet.

It will be noticed that the estimated amounts of the various kinds of pine found in Texas do not vary greatly from one another. The amount cut during the year ending May 31, 1880, of the long-leaved pine, is given as 66,450,000 feet; of the *Pinus mitis*, or short-leaved, 146,420,000 feet, including 30,290,000 shingles; and of the loblolly pine, 61,570,000 feet.

The amount of pine standing in the counties which have pine at all varies from 19,000,000 to 3,216,000,000 feet each.

From this description it will be seen that from such a simple Bulletin, with its map, any one can learn in a few minutes very accurately the condition of the lumber interest in any part of the country.

It will not be amiss, perhaps, to compare for a few moments the first Bulletin, that of Texas, with the sixth, that of Michigan, the two representing regions widely separated and differing also in climate, while the latter has been, until quite recently, one of our chief sources for the supply of pine-lumber. The area of Texas is about five times as great as that of Michigan. The Upper and Lower Peninsulas of Michigan are given upon separate maps, which are on a scale of forty miles to the inch. The engraving and coloring are such as to indicate portions abounding respectively in hard-wood, in pine, in pine and hard-wood mingled together, the portions also which have been cut over, whether of pine alone or of pine and hard-wood mixed, and the barrens.

A glance at the maps shows at once that the lower portion of the State, for a distance of sixty or seventy miles from the Ohio border, is covered with hard-wood, except as it has been cleared for agricultural purposes. Above this a broad belt stretches across the State, in which pine and hard-woods have grown together, but in which the pine has been mostly swept off by the lumberman's axe, and so thoroughly swept off as to leave no corresponding growth to follow it in future years, and the greater part of the hard-wood has also been destroyed. In the northern part of the Lower Peninsula some pine remains, but it is apparent that the axe has felled nearly all that grew in the vicinity of the streams, so that what little is now standing is reached only by means of railways built especially for the purpose of transporting it to market.

Looking at the map of the Upper Peninsula, the eye sees instantly that the pine-forests remain only in a comparatively small district bordering on the northern portion of Wisconsin and not easily accessible, while from that part of the State lying along the Menominee River and Green Bay, as well as along the upper shore of Lake Michigan and the southern shore of Lake Superior—in short, wherever they could be reached with facility—both the pine and hard-wood have been cleared away. There remains a belt of mingled pine and hard-wood stretching across the interior of the Peninsula, and a section, consisting chiefly of hard-wood, lying in the extreme northern and northwestern portions.

These grand facts in regard to one of the principal sources hitherto of our pine-lumber are seen at a glance from the clear and well-defined maps of the forthcoming census report. Apart from such a presentation to the eye, they could not be gained without much and careful inquiry, and then the facts would make no such clear and distinct impression upon the mind as they do at once when thus mapped before the sight.

The rate at which the supply of lumber in any region is increased or diminished can not be given by a single map, or the relation of the supply to the annual demand. These facts could be presented to the eye only by a series of maps showing the areas of forest as they become changed from year to year. So, in a single page of figures accompanying each map, we have the estimated amount of merchantable timber still standing on the 31st of May, 1880, and the amount cut during the year ending with that date. The comparison of these readily gives the probable duration of the supply at the present rate of consumption. Thus the statement for Michigan is as follows: In the Lower Peninsula the amount of white pine is:

| | Board-measure. |
|---|---|
| In the basins of the streams flowing into Saginaw Bay.... | 7,000,000,000 feet. |
| In the basins of streams flowing into Lake Huron..... | 8,000,000,000 " |
| In the basins of streams flowing into Lake Michigan..... | 14,000,000,000 " |
| Total..... | 29,000,000,000 " |

Cut for the census year ending May 31, 1880, including 2,988,600,000 shingles and 428,445,000 laths, but exclusive of 36,000,000 staves and 3,330,000 sets of headings, 4,068,773,000 feet.

It will be seen at once that, at the present rate of consumption, the white-pine lumber of the Lower Peninsula will be consumed in about seven years. It will probably last somewhat longer than this, because its increasing scarcity and the increased difficulty of procuring it on account of its remoteness from streams by means of which it might be easily floated to market, will advance the price, and thereby lessen the demand for it. The duration of the remaining pine-forests of Michigan will also be extended by the fact that the augmented price will lead to the substitution of the hard-woods for many purposes in

the place of pine. We see every day that the hard-woods are coming into use more and more for the interior finish of buildings, as well as for many other applications.

There is in the Lower Peninsula an estimated amount of 575,500,000 cords of hard-wood distributed over nearly 20,000,000 acres. About twenty per cent of this is suitable for lumber and cooperage stock. There were cut for the census year ending May 31, 1880, exclusive of 163,821,000 staves and 18,567,000 sets of headings, and including 6,038,000 feet of spool stock, 440,944,000 feet.

In the southern half of the Lower Peninsula the forest has been largely removed for agricultural purposes or used in manufacturing, although considerable wooded areas generally distributed still remain. In the upper part of this Peninsula the hard-wood is now being rapidly consumed in the manufacture of charcoal, to be used for the purpose of smelting the iron-ores with which that region abounds.

Passing now to the Upper Peninsula, it is estimated that the amount of merchantable pine-lumber still standing is 6,000,000,000 feet. There were cut for the census year ending May 31, 1881, 328,438,000 feet. The supply here, at the present rate of consumption, would last about eighteen years.

Of hard-wood there is an estimated amount of 124,500,000 cords, distributed over 10,000,000 acres. There were cut for the census year, exclusive of fuel and railroad-ties, 1,145,000 cords. The southern counties contain large areas of swamp covered with tamarack, white and yellow cedar, estimated in the aggregate at 62,500,000 cords.

We have not undertaken to give the full results of the census, even in respect to our forests and forest products. We could not do so, in the present incomplete state of the returns. We have only endeavored to indicate in advance some of the interesting and valuable results which may be anticipated from the publication of the census returns in regard to our forests and woodlands whenever that publication shall be made. We have sought to exhibit the method adopted in compiling the census, as showing the confidence which may be given to the results presented. Without doubt, under the careful management of Professor Sargent, with his able corps of assistants, we shall have set before us in the two volumes of his special report, with the accompanying maps, a great body of most interesting and important facts in regard to the present and prospective condition of our forests. We shall know, as it was not possible to know before, their value as sources of lumber and fuel, and for various uses in the arts. We shall know, as we have not known before, the various agencies by which the forests are destroyed, and the rapidity with which their destruction is effected. We shall learn, as we have not learned before, that, wasteful as is the process of converting our forests into lumber, more of our precious woodlands are destroyed by fire than by the axe. It has been ascertained, for instance, that in the compara-

tively small State of Massachusetts more than 14,000 acres of forest, valued at more than $100,000, have been recently consumed by fire in a single year; and in Pennsylvania 685,738 acres of forest are reported as burned over in 1880, with a loss of more than $3,000,000. We shall learn that the axe and the flames together are consuming our forests so rapidly that we are threatened with great evils on this account in the not distant future. Trees are quickly felled and quickly burned; they are slow to grow. The lumberman's axe can destroy in an hour the oak or the pine which has gained its stature and its worth only by the annual increments of a century. The spark from the tobacco-pipe of a careless tramp may kindle a flame which will speedily spread over some great mountain-side and sweep away the forest covering which has been growing ever since the beginning of our history as a nation. Great revolutions may come in our national life, and generations of men will pass away, before that forest covering can be replaced.

The forthcoming census report will show that we have 25,708 establishments for converting the trees of our forests into lumber, that $181,186,122 are employed as the needful capital for carrying on this work, and that the value of the lumber produced is $233,367,729.

The revelations of the census will show with new clearness that, in view of the rapid destruction of our forests and the evils threatened in consequence, there is no time to be lost in taking measures to avert those evils so far as possible. What measures in particular should be adopted it is aside from our present purpose to show. It is enough to say in general that we should do all that we can individually, and by legislative enactment where necessary, to prevent the further needless destruction of our remaining forests. We should be more careful and less wasteful in cutting them for the production of lumber. We should guard them more vigilantly, and, by the enforcement of severe penalties if need be, against those chance fires which result in evil, and evil only, without any incidental good to any one. We should encourage the reproduction of forests, by leaving a sufficiency of seed or mother trees on the ground where the forests are cut, and by carefully excluding from all such grounds the cattle, whose teeth and hoofs together are almost as destructive as the axe or the flames. It is impossible to grow valuable forests where cattle are allowed to range in them and browse upon the tender trees. In Europe, they have decided long ago that the woods are no proper pasture-grounds for cattle.

Finally, we should encourage the planting of many new forests on what are practically the waste lands of many of our States. Such lands can thus be made the most productive, pecuniarily, of all our lands, while in those States and Territories which are comparatively destitute of forests no land is too good to be devoted to this purpose, and no labor of the husbandman promises so important and so profitable results as that of tree-planting on the large scale. The "Northwestern Lumberman," Chicago, in its review of the lumber product

for the present year, says, "To own a saw-mill to-day, with ten years' supply of standing timber, is to have that which is far better and safer than a gold-mine in the Occident." The same paper also says: "The amount of timber cut from the forests of the Northwest" (meaning Michigan, Wisconsin, and Minnesota, chiefly) "in 1881, counting that made into shingles with the lumber, exceeded 7,000,000,000 feet. It requires some little grasp of the subject to comprehend such an enormous sum. Loaded on cars, green, it would make a train nearly seven thousand miles in length. The amount of money required to purchase it from first hands would be not far from $125,000,000."

With such statements relative to the consumption of our existing forests, from authoritative sources, and the well-known fact that the price of all kinds of lumber has greatly increased during the last ten years, while that of some kinds has doubled, there should be little doubt that, looked at as a pecuniary venture alone, tree-planting on an extensive scale will bring a sure and abundant reward to those who engage in it.

## ORIGIN OF THE DONKEY.*

By C. A. PIETREMENT.

THE majority of modern naturalists have long attributed an Asiatic origin to the domestic asses. They have believed that the species are derived from the so-called *onagras* or wild asses of Asia, which the ancients mention, and which are still met wandering in droves of greater or less size, from the northern part of the Altai Mountains to the southern regions of the continent. As late as 1862, Isidore Geoffroy Saint-Hilaire assumed that the primitive country of the ass was partly in Asia, partly in Africa, because, he said, "the onagra extends from Asia to Northwestern Africa." In 1869, however, M. H. Milne-Edwards considered it "well demonstrated that the ass is essentially an African species, which occurs in Asia only in a domesticated condition; and that all that the ancients, and modern travellers as well, have said of the wild asses or onagras of Syria, Persia, etc., is applicable to the *hemippus* and other varieties of *Equus hemionus*, and not to *Equus asinus*. The horse, on the other hand, appears to have originated in Central Asia and a part of Europe. It is presumable that the domestication of the ass was effected in Africa, probably in Upper Egypt or some neighboring country, and that of the horse took place in the region occupied by the Indo-Germanic peoples. If the civilization of Central Asia and Europe had much

* From a new work, "Les Chevaux dans le Temps prehistoriques et historiques" ("Horses in Prehistorical and Historical Times"). Translated and abridged for "The Popular Science Monthly."

preceded that of Egypt, we might have presumed that the Egyptians received trained horses from abroad before taming the ass that lived wild in their land; but nothing authorizes us to suppose that this was the case. In all probability, the Egyptians made use of the indigenous species, or the ass, before they did of the horse, an exotic species that never came to Africa till it was domesticated.

M. George, in his "Études Zoologiques," brings evidence corroborative of these views. Real wild asses are now found, according to him, only in Abyssinia, where they have the slate-gray color and the cranial peculiarities typical of the species.

The name by which the Semitic peoples call the ass, *hamar* (ancient Assyrian, *imeru*), a name signifying red or bright fawn color, is applicable to the hemione and not to the ass, and indicates that, confounding the two species as modern naturalists and travelers have done, they gave to the introduced animal the name which they had long applied to the similar but not identical native animal. M. Sanson was therefore right in calling the Oriental domesticated beast the Egyptian breed, or *Equus Caballus Africanus*. M. Sanson has also made a distinct race, the European, of the asses which are native to the Hispano-Atlantic center; and, as their restricted geographical area leaves no doubt that their original home was there, the propriety of this distinction can hardly be called in question. Many documents also indicate that no race of asses is native to the northern regions of the old continent. Herodotus, Aristotle, and Strabo, all speak of the absence of asses from Scythia and Northwestern Europe, and account for it by the severity of the climate, which, they say, the animals are not able to endure. They were perfectly familiar with that part of those regions which lies north of the Black Sea; so their testimony as to that part is decisive. In the time of Diodorus, three hundred years after Aristotle, horses were employed in the transportation of tin from the shores of the British Channel to the mouth of the Rhine; and this indicates that asses were still unknown or rare in that part of Gaul. There is evidence, however, that the ass had been acclimated in the time of Aristotle in some of the most temperate parts of Central Europe; for Frontin, in his "Stratagems," tells that Atheas, King of the Scythians, a contemporary of Philip of Macedon, being at war with the Triballians and hard pressed, sent around his whole unarmed population, with the asses and cattle, to appear on the rear of his enemies and cause them to believe that he was receiving large re-enforcements.

Even now the ass does not live in, by any means, all of the northern part of the Eastern Continent. Ujfalvey says that the animals live and breed at Semipalatinsk, where the temperature falls to 15° below zero, but that at Omsk they are "fancy stock," and are kept alive only with great care; and he gives statistics to show that asses and mules are very few in comparison with horses all through Turkistan,

there being only twelve of them to 415,660 horses in the coldest and most mountainous government of that country.

We do not know when they were introduced into China; but it is related that the Emperor Ling-ti (168–189) made them fashionable at his court instead of horses. The Abbé Huc says that they thrive in Thibet and the northern provinces of China. It is, however, certain that they were not domesticated by the Proto-Mongols, the ancestors of the Chinese, in Northern Mongolia; and there appear to be few or none of them now in that country; for travelers speak of large flocks of sheep, goats, cows, camels, and horses, but never mention asses.

There is no probability that the Aryans were better acquainted with this animal in their original home than the Proto-Mongols in theirs. The ass is not among the animals offered in sacrifice by the heroes of the Avesta, and is only mentioned once in that book. At the time the Mazdean law was given, the Iranians were in possession of Northern Persia, where the ass had been introduced, and had been captured by Tiglath-pileser I.

The ass was taken to India very early, and the law of Menu leaves no doubt of the antiquity of its use among the Hindoos. It, for example, probibits a Brahman from reading on an ass; declares that the Chandêlas and Swapâkas shall have no property but dogs and asses; and orders Dija, who had broken his vow of chastity, to sacrifice a dark or black ass to Niwiti, and to wear its skin, begging for a year, and confessing his sin, in seven houses every day.

Asses appear to have been in use among the Hebrews from the time of Abraham; in Assyria and the neighboring countries from the time of Tiglath-pileser I, and in Greece from the time of Hesiod, who mentions the custom of castrating mules; and Homer compares the rage of Ajax with that of an ass rushing wildly through the fields. The great Harris papyrus, describing one of the conquests of Rameses, speaks of the chiefs of Tonoutu as arriving at Coptos with their tribes, and bringing with them caravans of asses and men. In the same document, Menephthah I, relating his victory over the Mashonash and the Libyans, describes the "vile chief of the Rebu" as losing all his goods and precious things, and "everything that he had brought with him from his country, his cattle, his goats, and his asses."

The most ancient instances of the application of asses to useful purposes were in Egypt. A bas-relief in a hypogeum of Gizeh, of the date of the fourth dynasty, represents two droves of asses; and M. Lenormant remarks: "As to the ass, we see it figured on the Egyptian tombs as far back as we go. It is frequently represented in the tombs of the ancient empire, at Gizeh, Sakkara, and Abousir. The beautiful bas-relief on the tomb of Ti (fifth dynasty), representing a group of asses, of which a model was exhibited by M. Mariette at the Universal Exposition of 1867, has certainly not been forgotten. From

the time of the fourth dynasty, the ass was as widely diffused in Egypt as it is now. In the tomb of Shafra-Ankh, at Gizeh, is an item of a drove of seven hundred and sixty trained asses among the assets of the deceased, who was a high functionary of the court of the founder of the great pyramid. In other tombs discovered by M. Mariette, but not yet fully described, I have remarked cases of proprietors who boasted the possession of thousands of asses. . . . Furthermore, the facts on this subject derived from the study of the monuments were not peculiar to Egypt only. . . . In the paintings on the tomb of Noumhotep, at Beni-Hassan-el-Kadim, may be seen the arrival of the family of Aamon, that is, of the nomadic shepherds of the Semitic race, who came to establish themselves in Egypt under one of the first reigns of the twelfth dynasty (about 3000 B. C.). Their only beasts of burden are the asses that carry their goods and children."

Although asses are thus frequently figured on the ancient monuments of Egypt, no representation of the mule has been found there, not even on the numerous monuments built after the horse was introduced. The people had already a good stock of camels and asses, and their soil was not of a character to call the work of mules into requisition; and mules are still scarce in Egypt.

On the other hand, the Assyrians have left us but few figures of the ass; but numerous representations of mules appear in their bas-reliefs, where these animals are plainly recognizable by their ears and horse-tails.

The first mules in the East were probably produced in those regions of Asia lying between the Ganges and the Mediterranean littoral of Syria, a short time after the arrival of the first Mongolian immigrants into these countries, where, through their residence, the Asiatic horses and the African or Nilotic asses first met. It is, then, not surprising that the legends carry the existence of mules in Assyria back into fabulous times. The cuneiform inscriptions, moreover, furnish certain and quite numerous facts attesting the antiquity of the existence of mules in that and the neighboring countries.

The use of mules was condemned by the Mosaic law, and was not adopted among the Israelites till after the priestly power had been subordinated to that of the laity by the establishment of royalty. The most ancient mention of these animals among the Israelites refers to the mules on which the people of the tribes of Issachar, Zebulon, and Naphthali brought provisions to Hebron for David, after the death of Saul (1 Chron. xii, 40). After this they are frequently referred to.

The mule is mentioned in the Veda; and Strabo says that the Prasii, on the banks of the Ganges, had them at the time of the voyage of Megasthenes to India.

Herodotus tells of the mules which Cyrus had to draw his water-wagons on his march from Persia to the siege of Babylon, and relates a curious story of one of the mules attached to the expedition of

Xerxes against the Greeks. The markets of Tyre, in the time of Ezekiel, were supplied with mules by the people of Togarma, or Armenia.

According to Diodorus, Alexander, after the siege of Persepolis, brought from Babylon, Mesopotamia, and Susiana, a multitude of pack and draught mules and three thousand camels, with which to take away the treasure from that city; and, when the body of Alexander was taken from Babylon to Egypt, "four tongues were fixed to the chariot, and to each tongue a train of four yokes, each yoke composed of four mules, the whole forming a team of sixty-four mules selected for their vigor and spirit." Homer furnishes a number of evidences of the antiquity of the existence of mules in Asia Minor and Greece, and in one place declares them superior for certain purposes to oxen.

Not only do we possess fewer ancient facts respecting asses and mules than respecting horses, because their part in history has been less important, but the historical documents on asses and mules permit us to trace their past further back in the East than in the West, and this is easily explained. In the first place, the habit of preserving the memory of facts arose earlier in the East than in the West; and, in the second place, our facts relative to the Western ass are derived chiefly from the Latin authors, whose references are less exact, because they were apt to include in a lump under the designation of *jumenta* all the kinds of pack and draught animals, horses, asses, mules, oxen, and camels, that composed the baggage-trains of the armies whose exploits they related.

It is, nevertheless, true that the domestication of the European ass must have dated from a very ancient time; it must have followed very shortly the importation into the Hispano-Atlantic center of the use of dolmens and arms of polished stone. M. Boucher de Perthes has found in the peats of the Somme, some fifteen or sixteen feet below the level of the stream, an equoid skull, which M. Sanson has recognized as that of an African or Nilotic ass. The animal to which it belonged, or one of its ancestors, must have been taken there by man.

Only a few documents support the probability that mules existed in Southwestern Europe in very ancient times. Varro says that the senator Axius bought a stallion-ass for four hundred thousand sestertiæ, or $16,800. Columella's treatise on agriculture bears witness to the importance of work with mules among the Romans. This accounts for the high prices that were sometimes paid for particular stallions, for the species was neither rare nor new in Italy. The earliest mention of a mule in Rome, with a definite date, is that of the animals that drew the chariot in which Tullia rode over the body of her father Tullius after he was assassinated, B. C. 534.

The histories of the Roman wars contain several incidents in which mules appear to have been used in the army on a large scale, and of stratagems in which they were made to play a prominent part: as

when the consul L. Papirius Cursor, making war upon the Samnites, frightened the enemy with the noise of a drove of them rushing down the mountain and dragging large limbs behind them; and when Julius Cæsar, in the civil wars, prevented the Pompeiians in Spain from decamping by marching his mules with a great bustle by their camp, and making them think that he was retiring.

Our historical citations show, then, with great probability, that the two asinine races are natives of hot countries, the one of the region of the Upper Nile, the other of the Hispano-Atlantic center. For this reason they are difficult of acclimation in cold regions, while they are better able than horses to endure the torrid temperature of the diamond-regions of Southern Africa. Furthermore, the African or Nilotic ass was diffused from a very ancient period over a geographical area which extended at least from the Ganges to the Atlantic Ocean, while the European or Hispano-Atlantic ass has hardly got beyond the boundaries of his original country. The history of asses, then, as well as that of horses, testifies that the ancient migrations of civilization did not start from the western part of the continent.

## SPECULATIONS ON THE NATURE OF MATTER.*

By HENRY HOBART BATES, M. A.

THE nature of matter is still almost as unknown to us in its essence as it was to the ancients, since in its minute structure it lies far below the range of the senses, or of instrumental appliances, and, therefore, beyond that direct experimental field so necessary in furnishing primary conceptions to the mind. From the impossibility of originating entirely novel ideas (which would amount to creative power), we are forced to combine and recombine such conceptions as we have, derived from experiences within that excessively small portion of the scale of being within the ken of our perceptions and faculties. This perceptible scale has been somewhat extended in both directions by refined modern instrumental means, and thus the number of elementary concepts has been slightly increased, while precision has been added to those already in possession, by stricter modes of analysis.

The field, however, is still largely speculative. It might, therefore, seem unprofitable and unscientific to labor in it, were it not for the urgent necessity for and great value of some working hypothesis, however crude (if on the road to truth), as an aid and stimulus to further progress. Without hypothesis, we can not interpret or collo-

* Read before the Philosophical Society of Washington, January 27, 1883.

cate such facts as we gain ; while, without facts, we can not improve our hypothesis.

The great trouble about matter is to find out how much of it and what in it is material. Strange to say, there is nothing on which philosophers are less agreed. Unfortunately, our notions of matter are derived solely from sense impressions ; and that form of it which most impresses the senses is the most encumbered with fugitive and non-essential properties. We can not say with certainty whether these properties are positive or negative.

When upon a clear summer's day we gaze outward into a cloudless sky, we look apparently into clear and void space, except for the deep-blue diffused light. We recognize vacuity. Even while we gaze, perhaps a light, fleecy cloud forms itself before our eyes, and we form the concept of the creation of a material object. We know that it is not a mere apparition—it is a form of substance. Properties begin to be recognizable in it. It reflects light—it displays color—it moves. Should its development progress, we shall have still further evidence of its substantiality. It will grow darker and more dense. It will exhibit gravity, and descend in liquid drops or solid flakes, and these portions in turn will exhibit the typical properties, qualities, and reactions of matter.

Now, what elicited this bundle of realities out of apparent nothing? A mere local refrigeration—a flaw of nothing tangible—abstracted something from the invisible potential occupant of the space, reduced its volume, sapped its mobility, its power of holding its own, and properties began to appear. Death began its work, and, as the animus fled, the skeleton framework came within our ken.

We might rise by analogy from the nimbus to the nebula—from the terrestrial to the cosmical—and see with imagination's eye a similar inverse evolution producing the apparition of things substantial, which may be really but the *intaglio* of the realities. For that which consists merely in the negation of something can not be the truest substance. An ulcer is not more material or real than the healthy tissue before the latter gives urgent call for recognition of its actuality by inflammation, incipient degradation, and advancing dissolution.

It may be possible, however, to corner a reality by the reverse process. A fair type of matter is our block of ice. It is sufficiently substantial, and loaded down with properties. A simple exposure to different temperature conditions causes its sensational properties to drop off like old clothes. We soon come to a pair of invisible and intangible existences, investigable by indirect means only, of which sufficient knowledge has been gained to establish their discontinuous or corpuscular character, as imagined by Democritus.

This molecule we must take as the representative of matter ; for all masses of it, whether gaseous, liquid, or solid, are but aggregations of similar corpuscles. We can only pursue it with the eye of the

imagination; for, as has been shown by the molecular physicists, its dimensions are so inconceivably minute as to far transcend the mechanism of vision, since it would require at least twenty thousand in a line to occupy a medium wave-length of light.

But could the molecule even be magnified to visible and tangible dimensions, with a new light to view it by, it could not by any means be rendered visible, either in whole or in its parts, on account of its incessant and marvelous activity, both interior and translatory. That the gas-molecule did not get its interior motion from the heat of dissociation is certain, for, on being allowed to recombine, it yields up its translatory activity, and with it as many degrees of temperature as disappeared in accomplishing the dissociation. No means of wholly destroying the interior motion are known. By some *savants* it is regarded as primordial and ultimate. It is highly probable, for reasons which Mr. Taylor has pointed out,* that the hydrogen-molecule contains at least four pairs of revolving elements, revolving in different periods, and in contractile orbits, but with periods as undeviating as those of the moons of Mars. It is in the revolving or vibratory constituent of this couple that we seek the final essence of matter, though perhaps not to arrive at it. We must not endow it with gratuitous attributes, but it is surely an entity of some kind, having, in the first place, persistent and regulated motion. Secondly, it has inertia, or mass—the property of conserving *vis viva*. Thirdly, it has some bond with its fellow by which the motions of both are modified by a constant stress according to a definite law of distance, and this, following Newton, we call attraction. Fourthly, it has the complex property of interchange of momenta, accompanied by that of conserving and compounding motion by angular rebound upon an indefinitely near approach, which we name resilience, or repulsion. Dimension it need not have, nor any other property of masses; but nobody has ever yet succeeded in getting rid of the above four. This is not universally recognized, however, and the recent controversies of philosophy are owing to the strenuous attempts to reduce the number, especially of those called occult. Motion being in our ordinary experience a result, has not been so classified, and indeed has only more recently been recognized as primary. It is with causes that philosophy seeks to deal, and in our experience causation is a chain. Primordial motion, however, is as occult and mysterious as static force.

One class of philosophers, recognizing the self-existent character of motion, has exhausted ingenuity in the effort to deduce attraction from it, of course wittingly or unwittingly bringing into co-operation the occult force inertia, to obtain *vis viva*. Another class would deduce all motion from attraction: while in the attempt to contrive a mechanism to explain resiliency—the most incomprehensible of all in a body without parts—immensely greater complications and difficulties

* Annual Address before the Philosophical Society of Washington, 1882, p. 24.

have been introduced. Inertia, so far as I am aware, has always been accepted as an inscrutable fact, or ignored.

An entity with four unexplained properties is regarded as still a long way from satisfactory simplicity. But a more important consideration is that the entity is always found associated with its fellow or fellows in a dependent and artificial way (when identified at all), which indicates an advance from primitive independence and simplicity. The complexity of the simplest atom we know of has already been referred to. The resemblance of the atoms to manufactured articles was pointed out by Sir John Herschel; and not only that, but they resemble articles made in quantities by machinery, all exactly alike, like Waltham watches or Springfield guns. And the fact that any recognizable atom, like that of hydrogen, for instance, is always exactly the same thing, whether derived from the ocean or the coal-measures, or from the occluded gas of a meteorite, or inspected in the sun and stars, as pointed out by Maxwell ("Encyclopædia Britannica," ninth edition, article "Atom"), would seem to indicate that it must be the result of an undeviating process, and in its ultimate derivation made up of finally discrete entities, and not out of continuous substance, whatever that may mean. The fact, too, of its occurrence at such wide points of distribution, indicates the unity of the present scheme of evolution, as well as the great antiquity of its origin, and its persistency of type.

We have at present no clew to the evolutionary history of the atom. The atom I distinguish both from the ultimate particle without parts, and from the complex derivative molecule of the chemical elements, such as all those we know of are. In fact, these must also be distinguished from the still differently organized compound molecule of the chemical combinations, which can be taken apart, and the enormously complicated system of the organic molecule, as of oil or albumen, which, if a body so simple as iron contains more than seven hundred couples, must contain rotary elements which can only be numbered by millions.

The atom, or elementary couple, is conceived as having dimension, figure, and polarity, and also perfect elasticity, by reason of its harmonic vibration. We have to seek an origin for it if we are at all impressed with its artificial and evolved character. Its artificiality lies in its rotary motion; such motion being due to and maintainable only by a composition of forces.

The weight and ponderosity of matter have proved a stumbling-block to the conceptions of the later philosophers—especially after Newton had generalized them as attraction and inertia—far more than the equally unexplainable property of resistance, though why, it is difficult to say. Lucretius found no such difficulty with the conception of weight, for his corpuscles all naturally tended "downward," so uncosmical were his ideas. Le Sage revived and modified the hy-

pothesis of Lucretius, especially to get rid of the (to him) inconceivable notion of gravity. Those kinematists who follow Le Sage do so with the same avowed motive. Another school, with the same view, have revived the continuous notion of matter; out of which they have constructed an atom which has permanence and elasticity, but no avowed occult affection except inertia. It has not been further developed.

The difficulty in accepting the fact of gravity seems to be a metaphysical one, though even the metaphysicians have not held that conceivability is a criterion of objective truth. The irrelevancy of this objection has been well stated by Mr. W. R. Browne, in his article on "Central Forces" ("London, Edinburgh, and Dublin Philosophical Magazine," January, 1883, page 40), as follows: "I am not aware that the term 'unthinkable,' which is a new one, has ever been defined. Until it has been, it is impossible to say whether action at a distance is unthinkable, or whether the fact of a conception being unthinkable is sufficient reason, or any reason, for holding it to be untrue." The many instances of unthinkable truths within our familiar knowledge will readily recur to all in illustration, as, for instance, the infinite extension of space, the infinite approach of asymptotes, the nature of interminable series, etc. In fact, all forms of absolute knowledge are unthinkable. The refusal to recognize this form of knowledge has led to much heresy in other branches of exact inquiry—even in mathematics. The sentiment, however, such as it is, has led to many ingenious and futile devices in the branch we are now considering—among others, the invention of the vortex atom, before referred to.

The vortex atom belongs, not to physics, but to purely mathematical concepts; being an ideal abstraction—as much so as a surface, or a line, or four-dimensioned space—invented for the purpose of investigating problems in hydrodynamics. A homogeneous, incompressible, continuous, perfectly mobile but not miscible substance is an impossible entity, and it would seem an inconsistent one as to mobility; and, if vortex motion can not be destroyed in it, it is equally true that no means can be devised for originating it. An occult force had to be attributed to it, after all, as mass. Helmholtz, its inventor, discussed it as a purely mathematical problem; but its British adopters, struck with the remarkable attributes deduced from the postulates, set it up as the basis of a kosmos. By a similar appreciation, when that characteristic product of British genius, a modern plow, was carried to India—the land of theosophic contemplation—its enthusiastic foreign admirers, after having been carefully shown its merits, and instructed in its use, were found to have erected it in the center of the field as a god!

But, though we have no need of the hypothesis of an ether to explain away the weight of matter, especially since no such invention has been so perfected as to prove particularly successful for the pur-

pose, the establishment of the ether with any demonstrated properties might aid our conceptions of matter, and be concatenated with it as one of its higher forms. Maxwell has pointed out ("Encyclopædia Britannica," ninth edition, article "Ether") that, though many ethers have been proposed for various purposes, none have survived except that which was invented by Huygens to explain the propagation of light. Evidence accumulates for this hypothesis, in some form, for we have no other way of accounting for the facts, but the mechanism is still a mystery.

The very property of the supposititious ethers which is so fatal to all explanation of a static stress, like gravity, namely, the requirement of time for their functions, qualifies them so far as a vehicle of radiant manifestations. Were it not for the transmission of radiant energy in specific time, doubtless it would be far simpler and more satisfactory to explain the whole effect as *actio in distans*, under the necessary law of conservation, or on the Cartesian principle of contact. The phenomenon of electro-magnetic induction—which is believed to occur between the earth and sun, as a real material effect manifest in converted energy, and yet acting in lines transverse to the lines of transmission, and apparently simultaneous—even now outstands as unexplainable in any other way, for its mechanism certainly can not at present be comprehended. Nor is the mechanism for the transmission of the radiant forms of energy yet clearly made out, though some postulates about it having consistency and probability have been laid down. The fact that something supra-material is necessary and probable on other grounds gives encouragement to the idea that a basis for the atom can eventually be found.

The ether has been conceived under four principal modes of structure, all fashioned out of our concepts of matter. Two of these are static, and two kinetic. The first is the pseudo-concept of a continuous, colloidal plenum. This is a metaphysical, not a physical, concept; derived from an idealization of a false observation of matter which can not be realized consistently in thought with what is postulated of it afterward. As Maxwell happily remarks about the notion of homogeneous and continuous matter ("Encyclopædia Britannica," ninth edition, article "Atom"), "it is in its extreme form a theory incapable of development."

The second concept is that of a solid. This has been assumed as a conceivable way of accounting for the very high co-efficient of elasticity required by the undulatory theory, and also for the transverse mode of transmitting vibrations exhibited. The word "solid," however, can not have any meaning such as we ordinarily attach to it; and under any signification it is admitted that the theory is encumbered with several difficulties, some of which have been set forth by Professor G. G. Stokes, in his "Report on Double Refraction" ("British Association Report," 1862, p. 253).

Thirdly, the ether has been conceived to be the ordinary elastic gases or atmospheres freely expanded into space. But these have no co-efficient of elasticity sufficient to give them such expansion, and they would be liable to condensation and compression by their own gravity about the planets, which would cause a rise of temperature and dissipation of energy which would rob the ether of its permanent character. Besides, Maxwell has shown that our atmosphere expanded into space would be far too rare in the interplanetary spaces to satisfy the required conditions; nor is there any molecular velocity at all adequate to the propagation of wave-energy with the velocities observed, as will be shown further on.

This brings us to the fourth concept, which is that of a pure primordial gaseous plenum, of sufficiently high tension, and in the condition assumed by gases in a rarefied receiver, where the mean path is so long in proportion to the mean distance that a symmetrical movement arranges itself, according to the law first pointed out by Maxwell as a corollary from the equilibrium of pressure observed in confined gases, and the performance of gases in a rarefied space first observed by Crookes, that particles in free collision in space tend constantly to rearrange their motions automatically so as to move uniformly in all directions in radial lines from every point. With the gases experimented with the mean path at normal pressure and density is very short (only about $\frac{1}{250000}$ of an inch, when the molecules have a mean distance from each other of $\frac{1}{100000}$ of an inch), but, at the extreme of rarefaction which we are able to effect (about $\frac{1}{1000000}$ of an atmosphere, when the distance of the molecules is still only $\frac{1}{10000}$ of an inch), the mean path rises to about four inches; and C. T. Preston has shown ("Nature," vol. xxiii, p. 463), that could we carry the exhaustion to the third power of that obtainable, so that the distance of the molecules apart should be so much as one seventh of an inch, the mean path would be raised to 60,000,000 miles, since it increases in the triplicate ratio with the distance. But with the ether no such rarity need be postulated, since mean free path is but a question of size of molecule, and in comparison with the hydrogen-molecule the size of the particle can only be infinitesimal. It is clear, however, that, with the enormous velocity due to the particle, all the effect of continuity would be produced, so far as vision is concerned, by a mean distance apart, not merely of one seventh of an inch, but of many miles.

We may therefore assign to the ether any required free path, and any necessary density, tension, and velocity, all of these latter being imperceptible to molecular structures which float in and are permeated by it. The motions also of molecules in a gas so constituted would be practically as unaffected as in free space, since it is demonstrable that the resistance to motion offered by a medium such as the hypothesis calls for would be in the ratio of the motion of the moving mass to that of the particle of the medium, which in the case supposed would

be excessively small, the velocity of the radiant particles being equal *at least* to that of the transmission of light.*

It is clear that, by the use of the term "free path" by the inventors of this form of the ether, its particle had already been tacitly endowed with the ocult properties of inertia and resilience. Primordial motion was also attributed—an occult factor, which, with the other two, constitutes and conserves energy.

Such an ether serves to explain the phenomena of light, and the other radiant modes of energy, better than any other yet proposed. It, therefore, measurably serves its purpose. Prior to its invention, we had only—first, Newton's hypothesis of corpuscular emission, instantaneously propagated with explosive violence at an enormous but still uniform velocity, in all possible directions, in radial lines, which still were able to fill space at all points to unlimited distances—infinite and impossible results from a trivial cause; secondly, we had Huygens's scarcely more credible hypothesis of undulations, propagated, with the same instantaneous and uniform velocity in all directions, from a luminous point in a pervading statical solid or fluid medium—another infinite effect from a trivial cause. But by the hypothesis of its own independent linear motion, ever conserved—the parasitic energy alone being transferable, and by a mechanism different from the translatory motion—many difficulties are got over. The conservation of the linear motion is due to the law of radiant matter above stated, and also, I conceive, to another consideration, which tends to prevent the bombardment of the molecules, and consequent rise of temperature and distribution of energy, so fatal to the gravitation theory. It is that the only obstructive portion of the so-called material atom (which I have named the elementary molecule) lies in the extreme boundary; and even of this it constitutes only such fraction as the ratio which the dimension of the component particle bears to the semi-circumference of the atom, which is an infinitesimal ratio. The component, having a dimension and velocity of an order comparable with that of the ethereal particles themselves, can protect itself from collisions by a readjustment, without rise of temperature, on the same terms as obtain with ethereal collisions. Collisions, however, would be excessively rare—as much so as those of the particles among themselves—and an occasional collision could not destroy the atom, owing to the peculiar bond of the component with its fellow; but its motion would be merely compounded into a gyration. The real field

* The velocity would really be at least one third greater. It has been shown, by a calculation of Maxwell's ("London, Edinburgh, and Dublin Philosophical Magazine," 1877, p. 453), that, in a gas constituted as assumed, the velocity of the wave-motion would be to the velocity of the particle in the ratio of the $\sqrt{5}$ to 3; that is, about ·745+; which would give a velocity for the ethereal particle of nearly 250,000 miles per second. It is highly probable, moreover, that some forms of electrical radiant energy surpass light in velocity of transmission.

of attraction and bombardment would be the void focus of the disk, toward which the resultant of all the forces in the ring would tend, as a corollary from the deduction from synchronism that the force which binds the atomic couples varies directly as the distance, instead of as the inverse squares.

In its passage through the disk-atom the ray takes up and conserves the dropped motion as a transverse vibratory motion of some kind; or, as Maxwell styles it, "some vector property which does not interfere with the motion of translation" ("Encyclopædia Britannica," ninth edition, article "Ether"), and which it can impart again to the revolving systems of atoms through which it travels, in an inverse mode to that of its derivation. The invention of the mechanism of this vector motion has its difficulties. I consider, first, that the radiant energies are not exhibited in matter, except upon a certain degree of disturbance, showing itself in a violent clashing of systems, either from the forming of new combinations or from incandescence resulting from the accession of energy from without or within. These clashings disturb the equilibrium of the atomic orbits, and occasion their rapid deformation by harmonic vibration in elliptic orbits whose rectangular axes rapidly alternate from major to minor while the agitation is kept up. Now, the circular movements of the components do not disturb the uniform transit of the linear ray; but the rapid approach and recession of the components in passing through the violent elliptical transitions cause a rapid alternation of stress in the field of stress through which the rays pass—since the stress varies as the distance of the components—causing a vibratory deflection of the stream of particles, due to the variation of the attractive force, in all rays except the polar ray, and in the plane of the ray normal to the plane of stress. Since the disk-atoms lie in all planes, we shall have transverse vibrations in all directions; but, if the rotating disk is gyratory, as would be the rule and not the exception, the identical ray would receive a vector or corkscrew motion, similar to what is called for by observation. The amount of deflection I take to be the index of refraction of the molecule.

It may seem unaccountable that the whole ray should undulate from passing through a single locality of oscillatory disturbance, being composed of discrete and unconnected particles; but we may compare the parallel phenomenon of a jet of water, forcibly ejected to a great distance through a hose-nozzle, which exhibits to the eye similar undulations when the source of discharge is slightly and rapidly oscillated.

It may also seem incredible that any orbital movements could be permanent enough to sustain oscillatory vibrations of such inconceivable frequency as those which luminous rays are known to execute; but I have computed, from the probable dimensions of the hydrogen-molecule as assigned by the molecular physicists, and an orbital veloci-

ty due to an ethereal origin for the components, that many hundreds of revolutions must occur for each transverse oscillation or elliptical deformation.

In its passage through other disk-atoms in equilibrium which are in harmonic tension with the vibrating ray (and therefore not diathermal or transparent), I conceive that the vibratory ray is able to invert the process and agitate the diaphragm of stress of the system, as a fish-line does the surface of a pool; thus setting up an inverse commotion and vibration of orbits due to accession of motion, accounting for the effects of reflexion, the absorption and conversion of light into sensible heat, and the chemical and actinic and electrolytic effects observed. The diverse nature of some of these effects may be due to the extremely diverse character of the vibrations, both of the disks and of the rays; e. g., the polar ray, which would have a pulsatory vibration.

The primitive gas would not, any more than our own elementary gases, experience any difficulty in holding its own, and maintaining equilibrium forever, under any ordinary state of diffusion, by reason of its perfect elasticity. But with emerging matter, or crippled ether, among other properties gravity becomes apparent; and though hardly sensible, at first, yet within the enormous cosmical aggregations of this novel drift, pressure and condensation would ensue at some point so great that in the absolute cool of space the critical point of endurance would be overcome, and some molecular systems would cripple and collapse, with the resultant liberation of their motion and clashing and agitation of the neighboring systems known as rise of temperature. The falling in of others would follow and increase the commotion, causing local expansion, and currents to a region of less pressure—sometimes, no doubt, with enough velocity to carry them entirely into free space, and beyond the control of the system.

It would be futile to attempt here to follow out all the complex consequences of this initiated evolution, but it is clear that the temperature of the whole aggregation must rise until, at the outer boundary, where alone the liberated energy was able finally to escape, the temperature must stand constantly at the heat of dissociation of the particular element or elements being evolved at any stage of development. But radiation would proceed only at the rate allowable by the nature of the combinations going on at a specified stage, though it would be practically constant for long periods, as the supply of motion could be extricated. The aggregation could not become a simple cooling body while molecular mobility remained.

Amid all this commotion and lavish escape of energy on the wings of the ether, not one particle of matter is lost. It can not recover its linear motion. It joins in the dance that is going on, and contributes to swell the molecular weight of whatever system of molecules is being evolved at that particular stage of development.

The absolute synchronism exhibited under all amplitudes of vibration by the disk-atom indicates the same law of central force as that of the pendulum in its synchronous forms, or the spring-governor; and if attraction be the bond, it is a similar law of attraction, namely, directly as the distance. This is the Newtonian law of gravity within the homogeneous sphere, and thus by actual demonstration the attractive atom observes the same law as would the earth were it penetrable —namely, the inverse squares of the distances within the sphere.*

The identity of the radiant particle with the component of the atom is inferable. It possesses the requisite properties of mass and resilience, and sufficient linear motion. Whether it should also have attraction imputed to it as inherent depends on whether that property in the molecule, where alone it is observed, is derived from the particle. If not, the latter needs only mass to conserve its deflections and its course under the first law of motion, and resilience to secure its compensatory readjustment in equilibrium. Even if possessed of gravity, the enormous proper velocity of the particle would render such an affection totally undiscoverable, because the Newtonian curves of the second order resulting from the composition of force could be nothing less than hyperbolas, whose branches would be wholly undistinguishable from straight lines.

No means at present offer themselves for suggesting how such a discontinuity of action as is implied by the change from simple linear motion to the balanced movements of the atoms could have occurred; and especially how a law of attraction according to inverse squares of distance, which we must postulate, could change for one so extraordinary as that observed within the atom, namely, directly at the distance. The law referred to rather resembles that of our summer whirlwinds, wherein the centripetal force, i. e., the pressure from without due to the rarefaction within, seems to vary directly as the centrifugal force, and therefore as the radius, until equilibrium of rotation is established. These also display a species of attraction within the vortex; and some forms of matter—as iron—evince a similar polar attraction at sensible distances when rearranged by vortical motion. But such a theory does not commend itself by that simplicity which we should expect in the region of the atom.

The evolution of the atom or elementary molecule from the particle, even if real, is not continuous with the present order of nature within our observation, and need not be, any more than the formation

* This parallel holds good only for the balanced couples themselves, in which I have assumed the cause of the stress to reside. The intensity of the stress would not vary as the distance from the center for a third body, as in the permeable sphere, but the field would be like a strained elastic *tympanum*, with varying tension dependent on the separation of the elements. The mathematical discussion of this field of force would be most interesting, involving, as it does, the investigation of all the phenomena of refraction and reflexion.

of a storm-cloud is a continuous process in the atmosphere, or the appearance of a rash in the human patient is continuous. But the cataclysm once accomplished, a new uniformity must have supervened, and evolution proceeded from that point continuously from the simple to the more heterogeneous, in accordance with strict dynamical law. Even now the history of such evolution is as plainly to be read as the history of the growth of plants in a forest. Some of the nebulæ give evidence of being collections of the simplest primordial gases, or mixtures of such, by the simplicity of their spectral lines. Even in these, radiant energy is being set free, or we could not know of their existence. We also know that the sun and stars are tremendous laboratories for the organization of matter, where disused motions are liberated in torrents. The creation of molecules in gradually increasing complexity seems to go on by discontinuous steps or stages, in accordance with the discontinuous and discrete nature of the elemental factors; and its products at each certain stage are all duplicates, whether in this sun or that. Every increase in complexity apparently liberates motion, which, by the law of conservation, must escape as an efficient agent. With the constant escape of energy, however, solidification finally ensues, as our planet bears witness, and the mobility of the molecules practically ceases. Gases and moisture, however, remain over to supply mobile conditions, and the work goes on. At this stage new supplies of sufficient temperature from without are capable of reversing the process to a degree, restoring mobility, and introducing new modes for the play of affinities. The radiant energies of the sun supply for our planet the extraneous motion necessary to carry the complexity of the molecule higher than the simple running down of matter can do, and we have the chemistry of the carbon compounds. Aided by some discontinuous step, which we can not as yet identify or explain, vitalized functions appear. The wondrously compound molecules of the tropics are evolved, oils, starches, sugars, spices, ethers, and alkaloids—magazines of stored-up *vis viva*—and, by the assimilation of these, physiological phenomena in sentient beings are carried on, accompanied by the mysteries of will and consciousness, and the still more unaccountable facts of succession and heredity, which mock, if material, all efforts at conception or comprehension of matter in its ultimate essence.

The actual amount of energy stored up in the elementary molecule is not calculable, but it must be enormous. The amount of motion can not be certainly known, for we do not know whether any could have disappeared at the birth, and the mass or atomic weight of the ultimate particle can not be known by any means now in possession. The great rapidity of oscillation across the small orbit has been vividly illustrated by G. J. Stoney ("London, Edinburgh, and Dublin Philosophical Magazine," August, 1868, page 132), by the consideration (since numbers convey no idea) that they bear the same ratio of

frequency to a second of time that a second (or a wave of the hand) bears to 30,000,000 years—one of the geologic periods, during which a race of animals may have been evolved and have perished.

Such inconceivable velocity of rhythmical motion in the elementary molecule points to some cause more potent than the action of any mere static force combined with any mere energy of position. The same is true of the more complex molecules of our experience—say of iron, or calcium—displaying hundreds of spectral lines. We can not suppose these inconceivably energetic motions to have been all set up by any mere precipitation which evolved the element, nor to have existed in their present organization from eternity. The same is, of course, true of the organic molecule. Their conserved energy lies in the vast reserve of *vis viva* stored up in their complex interior movements. A few ounces of organized food suffice for the expenditure of a mountain-climber for a whole day. An apparently inert explosive is traversed by a tiny spark, or pressed too closely, and the increased swing of one molecular orbit sets off the whole mass into new paths and more economical relations by which a vast amount of motion is liberated, to appear as temperature. This temporarily expands the whole mass many volumes, but, as the agitation subsides, the now surplus energy dissipates by radiation, and, being picked up by surrounding bodies, temperature becomes equalized. This mechanical modification and distribution of motions, resulting in final equilibrium, is more intelligible than the instantaneous setting up of immense velocities and momenta by precipitation from a state of absolute rest.

Besides, research proves that there is absolutely no room for any such energy of position as was fancied. Sir William Thomson has shown, by considerations of high probability ("Nature," vol. i, page 553), that the distance from center to center of molecules in solids and liquids can be but little more than the diameter of the molecules. In liquids, from their great resistance to compression, the practical point of contact has been reached, but temperature conserves mobility.

The phrase "dead matter," once deemed so eminently characteristic, now seems absurd. To deprive matter of its inherent activity is indeed one of the most difficult problems we can encounter. To do it, some means for the disposal and transfer of its energy must be provided. Until very recently, no means were contrivable for subduing the elementary gases, but, by resorting to the most extraordinary compression, in conjunction with the lowest temperature procurable by artificial means, the feat has been accomplished. There is a way, however, of pitting certain elements against each other by taking advantage of their commensurate atomic periods, and in this way we get our chief supply of artificial heat. This is due to our fortunate store of carbon and hydrogen, free and combined, and of uncombined oxygen. The known distances of the molecules of the gases above named under normal temperature and pressure give no clew to the

enormous amount of energy liberated by their combination under any supposable attraction—certainly not under any that is observable.

We are, therefore, compelled to recognize the latent energy in matter. The kinematists were profoundly impressed by this now established fact, and, as is the usual tendency of the promulgation of any brilliant discovery, they undertook too much with it—to wit, to construct a kosmos.

By a similar tendency, after the establishment of the laws of motion, and of universal gravitation, followed by the discovery of the conservation of matter, and later by that of the conservation of energy, and the perception of the energy of position, these brilliant advances in knowledge of the absolute had encouraged the hope that the ultimate could be explained. Matter was then viewed almost entirely in its statical aspect—as is even now too much the case, for we still see in our chemical text-books molecules absurdly represented by geometrical diagrams—and, from the fact that motion *does* actually result from attraction and position, it was natural to relegate motion to the category of effects. There were, then, but two factors in the problem—matter, and its occult affections. But as matter they took the old "dead matter," in the last gasp of its evolution, freighted down with its bundle of inert properties of negation, and, to evolve a universe, simply credited it with its virtue of position, and left it to the action of the weakest of its affections, gravitation, to run over again a short portion of its normal course.

Even then, the surprising result appeared that it would galvanize itself into life with activity enough to supply the radiant energy which our sun now exhibits for a period of some 20,000,000 years. This, whether we follow the meteoric hypothesis of Mayer, or the contraction hypothesis of Helmholtz, which have been held to be the only conceivable hypotheses. How sublime the solution of the problem could we, in the place of these *cinders*, put into the mathematical mill the true data! James Croll, in groping for some adequate data to explain the duration actually needed for the exhibition of solar energy of which we have evidence, suggests ("Climate and Time," page 353) that, on dynamical principles, given two masses each one half the sun's mass, moving directly toward each other with a velocity of 476 miles per second, sufficient heat might be accounted for to cover an emission at the present rate for 50,000,000 years. The surplus velocity, over and above that due to gravity, he derives from stellar proper motion; but, while the supposition is violent and unphilosophical, both in respect to the large proper motion assumed, and particularly as to the assumption of direct collision, in the plurality of cases called for by the multitude of suns, the result is still grossly inadequate. The problem is insoluble from pure dynamical considerations. They take no heed of the most important factors—elementary specific heat, elementary affinities, elementary motion. When we once succeed in

legitimizing the conception that suns and stars are evolved, not out of *débris*, and weak statical force, but from the primordial plenum itself, equipped with latent power in equilibrium, we can view them as they apparently are—perennial fountains of energy—incandescent lamps of eternity—drawing their supplies from the mysterious stoppage of primordial motions, with the accompanying evolution of chemical elements, and the radiation of liberated energy in torrents.

Energy of position is undoubtedly a factor, among others more important, in an evolving nebula or sun. It should be given its due value, but no more. There is evidence to show that even the translatory motions of suns and worlds can not be wholly accounted for by gravity alone. This is furnished by the large proper motion of some of the stars, particularly the notable instance of 1830 of Groombridge's catalogue, with a linear velocity of at least two hundred miles per second, if observations are to be trusted. An analysis by Newcomb proves conclusively that all the stars of the visible portion of the universe, and all the possible dark masses which could exist there, are widely incapable either of furnishing a star with such an amount of motion, or of stopping it.

The recognition of kinetics, then, in conjunction with dynamics, is what I desire to call attention to, in our philosophical attempts to extend our generalizations. We need to take note of all the forces and factors which we can perceive; and even then it is probable that our field of inspection will be too restricted to yield a satisfactory insight into that which was born from eternity. But that should not induce us to settle down on a "good enough universe" for finite comprehension, nor plead for boundaries to the infinite and eternal. Some mathematicians have invented a space cut down to finite comprehension. The trouble with these finite infinities and limited universes is, that they do not satisfy the mind, nor the definitions.

Although the course of the present order of creation is far longer than can be assigned or imagined, and, even as to our solar system, illimitable as measured by our cycles, no doubt it runs its course, for we can see the evidence of progressive change. The struggle for the elimination of energy in its entanglement with mass is a fiercer and more protracted one than we dreamed of, but it goes surely on to its termination. The energy by which the small vehicles were possessed escapes by slow dissipation back into the great storehouse of equilibrated power whence it was arrested, as gases return to the parent atmosphere from the rotting wood of the forest. The molecule is never finally taken apart, that we can see. The skeleton-heaps, in rigid and icy bonds, wander forever as *débris* and dust through the streams of space. Their amount, however, is so infinitesimal compared with the infinite magazine of their elements which has never been subject to change throughout the eternities, that they may be regarded as but the calculi resulting from the merest nodules of local and tem-

porary inflammation — imperceptible to the health of the infinite corpus.

Thus I admit, with the pure dynamist, that the material universe, or successive material universes (if such a solecism is pardonable), as manifestations of matter and motion, are concatenated with time, are born, run their course, and fade away, as do the clouds of air. But the infinite reservoir of power wherein they occur as disturbances remains. What can cause these manifestations of power—these droopings of energy, with their complicated results? This is beyond our finite ken; but it is certain that the mere running through of its course of a finite evolution does not end the eternal, the infinite, and absolute. Nor can the mind be restricted to such a conception by any argument about the limitation of its faculties.

## THE LEGAL STATUS OF SERVANT-GIRLS.

By OLIVER E. LYMAN.

SHORTLY after the Flood, as we are informed, Abram's wife turned her domestic, Hagar, out of the house on account of her arrogant conduct, which is perhaps the first authenticated instance on record of trouble between mistress and servant-girl. This sort of trouble, which began so early, still survives in forms so various and often so exasperating as to raise the impatient question whether the serving class is the only dark part of creation which improvement has failed to reach. The question is, no doubt, full of aggravation and discouragement, yet there has been improvement, but it has been of slow attainment, forming no exception to the great law of progressive social amelioration.

Social changes, it is to be remembered, especially of the alleviating and elevating kind, are always slow. We are beginning to talk about social evolution, and the new science of sociology which treats of it; but we have to take ages into account before we can realize any positive conception of advance. Much of the barbarism of early society clings tenaciously to the domestic relations, while the modification of human nature and the corresponding mitigation of social imperfections go on but very gradually, tardily, and partially.

A still further reason for the slowness of improvement in the present case arises from the peculiarity of the relations involved. In times of early violence, it is the weak that are subjugated and enslaved, and, as civilization advances, it is ever the lowest and most ignorant class of any society that falls into the condition of menial servitude. The feeblest, the least competent, the least provident, naturally sink to the bottom of the social scale, and become the helpers, the dependents,

the drudges, and the servile appendages of the classes who have wealth, intelligence, and power. In domestic life these relations become organized with the abject class at the base of the social structure. Improving agencies will obviously not take effect alike upon the higher and lower elements. Many causes will operate powerfully to maintain separate interests, to favor the superior class, and to hinder their inferiors, so that servants will be the last to be reached by elevating agencies.

How slowly ameliorating changes in the domestic relations have proceeded, and how long their worst features have survived, are shown by the tenacity with which a vicious system of domestic servitude was clung to even in this country. Multitudes still remember the order of things in which half the country bought their servants from the auction-block. That primitive condition in which the menial was a merchantable chattel, with hardly more rights than a brute, continued down to these times, and has been got rid of only in the present generation. The slave system could have lasted as long as it did only in a form of society in which the menial class was low, degraded, and without influence. And that the slave system has in turn widely reacted to promote the social debasement of the working-class there can be no doubt. The slave system, of course, grew more and more anomalous as the sense of justice and humanity strengthened among the people; but we must not forget that slavery in this country was not destroyed by the moral reprobation of the community. It was defended as an historic and permanent order of society until it was incidentally terminated by revolution. It is now easy to execrate its atrocious forms, but we have by no means escaped from the baneful influence of many of its ideas. The idea of an abject menial class is still entertained as a part of the normal constitution of human society, while the associations of a degrading and but recently abandoned system are still potent for the debasement of those who continue in the relations of domestic service.

But, in spite of all this, the serving class, however disabled and degraded, will be found to have participated much in that general movement which we term the progress of society. Civilization may have been staggered by the "servant-girl problem," but it has not wholly broken down before it. The mistress can no longer kill her perverse domestic with impunity—although she may often think this is a step backward instead of forward. General tendencies have been at work which have put an end to the ancient order in this respect. In the early ages of domestic servitude, one of its incidents was the power of the master over the life of the servant. This prerogative has long since disappeared, though not because of the sixth commandment, or as a result of law reform, or the enactment of protective legislation. It was the culminating effect of a succession of natural causes, whose operation was gradual and extended over centuries. By

captivity in time of war, or by the voluntary submission of the indigent, the prosperous and opulent became possessed of numerous servants, whom they chastised, sold, killed, and subjected to unlimited jurisdiction generally. In time the master possessed so many of these abject creatures that their numbers surpassed the accommodations of the household, and it became necessary to quarter them out upon the fields they cultivated. Here they lived in hamlets, and were called villagers, or villeins. Living apart from the master, it became less easy for him to keep a strict watch over their behavior, or to compel them to labor by chastisement. To incite them to work, gifts of money were made, and better results were obtained by making the pay proportionate to the results accomplished. Thus the master, using bribery instead of compulsion, and being removed from constant personal contact with his servants, had less occasion to become enraged at their short-comings, or to visit them with severe punishment. The exercise of dominion over life became less frequent, then ceased, and with a growing sense of justice the arbitrary power was forever lost, though it took centuries of the slow-working processes of evolution to accomplish this result. Potgresserus says that not till the twelfth century was the power lost.

But if progress has brought amelioration to the servile class and promises still more, it has brought also its disadvantages, some of which are the results of changed and improved relations. In the early ages masters and servants were more nearly alike in employments and manners of living than they are now. The acquirement of wealth and the luxurious habits which wealth introduced destroyed this degree of equality; the additional advantages inured to the benefit of the master alone; the servant remained indigent. The effect of social progress was thus to separate their lives as well as their interests. Servants constitute an isolated class. By an unwritten social law they are cut off from intimacy with their superiors, and consequently fail to reap the advantages which follow a community of interests with those above them. They fail to be leavened by the influences which act for the elevation of the community at large. This has operated to retard their progress and elevation, and produces aggravating effects which are more marked in our own republican country than in those countries where social gradations are more definitely established. Even in slavery there was a certain community of interest and responsibility on the part of the master, of which we see but little in the surviving forms of domestic servitude. This isolation drives servants to self-defense against the iron hand of control on the part of masters and mistresses, and results in a spirit of antagonism, leading to tacit conspiracy against those whom they regard as their enemies. Obligations sit lightly upon servants, and they habitually study to promote their own interests by unscrupulous arts and all kinds of dishonest practices. This may be deplored, but we may well ask, What are the

servants to do? They are a disintegrated as well as an isolated class, and can gain but imperfectly the benefits which arise from combination. Equality is the universal theory; why, then, should they not demand increasing privileges, and rebel against the circumstances that keep them down?

But slow as has been the improvement of this class, and notwithstanding their humble social condition, and although they are too frequently regarded as a lower race of beings, with no rights except to obey, yet they have reached a stage of progress that entitles them to the protection of law, to which they are amenable also like all other people. The servant-girl has a legal status just as much as her mistress, and rights which ought to be held sacred, and, if they were so regarded, one important step toward the amelioration of the relations of lady and servant would be taken.

The relation of mistress or master, as the case may be, and servant is based upon *contract* only, and the two parties to the contract are upon an equal footing so far as rights are concerned. They differ only in what they agree to do—one is to work, and the other to pay—and thereon hang all the law and the prophets. It naturally follows that physical punishment can not lawfully be administered to a domestic. As Chancellor Kent said, "that is not an incident of the contract of hiring." It is hardly necessary to enlarge upon this right of servants, as the physical punishment of a domestic is rarely, if ever, heard of.

In the case of slavery, where the servant was owned, it was assumed to be for the interest of the master to provide medical attendance in time of sickness, but the free servant has no such claim. If a servant-girl falls sick, the mistress is not legally compelled to take steps to restore her to health. According to both Chancellor Kent and Mr. Story, the party hiring is not bound to provide a servant with medical attendance or medicines in case of sickness.* If a gentleman at the servant's request sends for a physician, he is not liable to pay the doctor's bill unless he omits to make known who requests the services, or unless he exceeds his authority, or expressly or impliedly engages to be answerable, either by directly promising to pay for them, if rendered, or by doing or saying something which justifies the doctor in supposing that he engages to pay him.†

But if the gentleman has hired a doctor, and given him to understand that he will pay him, he is bound to pay what the services are reasonably worth; he can, however, at any time give him notice that he will not be liable for further services.‡ If he calls the doctor in to attend the servant without the servant's request or consent, he must foot the bill; it being considered merely a generous act on his part.* A lady, too, under the same circumstances becomes similarly liable—provided she never had a husband or has buried him. If she is still

* 2 Kent, 298; 2 Story on Contr., § 1,298.

† 41 How. Pr. (N. Y.), 370.

‡ 1 Bosw., 441.

* 2 Story on Contr., § 1,297.

fettered by one, there seems to be some doubt as to whether she can make a valid contract that will bind anybody at all to pay the doctor. The law is not well settled. It may be said, however, generally, that she can not bind her husband, because the obligation of a husband to furnish medical attendance does not extend beyond his wife and own children, and he is under no obligations to provide it for a servant. And, as such attendance for a servant can hardly be called a necessary which the husband must provide the wife, she can not be considered as his agent for the employment of the doctor. So, too, she can not, as a rule, bind herself, because her identity is merged in that of her husband. She is not *sui juris*, and has no right to contract.* But, if she has separate property, the case may be different. In New York she can be held liable on her separate estate, if the intention to charge it is declared in the very contract, which is the foundation of the charges.† The rule everywhere, however, is not the same. There is a conspicuous lack of uniformity on the subject of married women's rights. Some day uniformity may be obtained. If those ladies who cry for the right of suffrage would shed half of their tears for a settlement of the laws pertaining to married women, they would accomplish results worth striving for. But to return to the doctor. The poor man, at present, had better take care when a married woman comes to employ him for her servant, or he may be "left out in the cold."

Although not bound to furnish medical attendance and medicines, it seems the party hiring is bound to furnish proper food, and to support the servant during her sickness or disability, so long as she remains in his or her employ.‡

Another right which a servant-girl has, is a right to the enjoyment of a good character—provided she has one—and the law presumes she has it until the contrary appear.# There is, unfortunately, a tendency on the part of a great many people to speak too freely, too thoughtlessly, and even maliciously, of the characters of others. The more marked the inferiority in social position of the person talked about, the greater the freedom with which the unbridled tongue wags; and just in proportion as the maligned person's station in life is lowlier, the injury done is the more irreparable. So it frequently happens that the character of one who has lived in a menial relation to us is spoken slightingly of, in a manner not justified by the facts. Thoughtlessness of the consequences of idle words, revenge for some act of the servant, or some other motive, may be at the bottom of it, but they afford no justification. The law protects her—or will, if she has cash enough to invoke its protection, or can persuade a lawyer to take her case on speculation. If, however, the communication is made by a person acting honestly and without actual malice, then, even though it be

* Schouler on Hus. and Wife, § 123.

† 22 N. Y., 450.

‡ 2 Story on Contr., §§ 1,297, 1,298.

# Starkie on Libel and S., p. 19.

defamatory, the law protects the one making it. Servants bear such a peculiar relation to society that it is deemed necessary, for the common protection and well-being of its members, that honest and proper communications in regard to servants should be freely made, and that those called upon to make such communications should not be hampered by the apprehension of vexatious litigation. The good of the many is not to be sacrificed to save the few from injury. We see the same principle of protection in regard to communications made respecting the solvency of traders, the skill of professional practitioners, the trustworthiness of persons in confidential positions. The welfare of society demands that they be made freely, faithfully, and truly, and to give a servant a good character that is undeserved is a grievous offense.

On the other hand, one who designedly gives a bad character not deserved, under the pretense of discharging some duty to herself or to society, offends against justice and humanity, and the law throws no protecting cloak around her words. On one occasion a gentleman unasked wrote a letter in regard to a servant's character to another party, with the result of injury to the servant. The man was sued, and the jury found that he had acted maliciously, and rendered a verdict against him. The judge remarked: "I do not mean to say that, in order to make libelous matter (written by a master) privileged, it is essential that the party who makes the communication should be put into action in consequence of a third party's putting questions to him. I am of opinion he may (when he thinks that another is about to take into his service one whom he knows ought not to be taken) set himself in motion and do some act to induce that other to seek information from and put questions to him. The answers to such questions, given *bona fide* with the intention of communicating such facts as the other party ought to know, will, although they contain slanderous matter, come within the scope of a privileged communication. But in such a case it will be a question for the jury whether the defendant has acted *bona fide*, intending honestly to discharge a duty, or whether he has acted maliciously, intending to do an injury to the servant."*

In another case, a person told a servant girl's mistress that the girl was irregular in her conduct. The result was, she lost her place, and sued her defamer. The judge remarked: "If a neighbor make inquiry of another respecting his own servants, that other may state what he believes to be true; but the case is different where the statement is a voluntary act; yet, even in this case, the jury is to consider whether the words were dictated by a sense of the duty which one neighbor owes to another."†

Voluntary communications are looked upon askance. Stronger evidence is necessary to show that they were made in good faith than when the statements are made in response to inquiry.‡ And if a lady

* 8 B. and C., 578. † 1 Car. and Mar., 104. ‡ 8 B. and C., 578.

unasked displays a forward and officious zeal in giving a character prejudicial to a former servant, it will be a material guide to the jury in ascertaining the real motive.* The mere fact, however, that a communication is voluntarily made does not of necessity render it unprivileged, and, if the publication is warranted by an occasion apparently beneficial and honest, and there is no malice, it is not actionable.† If, for instance, a lady who has given a servant a good character finds that she was not justified in so doing, it is her right and it becomes her duty to communicate the facts to the person to whom the other communication was made, in order to prevent that person's being misled by the previous recommendation, and such a communication is privileged.‡ So, too, if a person to whom a servant has been recommended finds out that the character given was not justified by the servant's actions, and informs the lady who recommended her of the fact, and cautions her against giving recommendations for morality or honesty, this is, in the absence of malice, a privileged communication.# Where a lady gives a character in response to an inquiry, she will not be presumed to have been actuated by malice.‖ Even if what she says is untrue, she can not be successfully sued, unless the servant can prove that she spoke maliciously, and knew that what she said was untrue and injurious.△ And she need not prove the truth of her statement unless it is plain that she was actuated by malicious motives. If under such circumstances a *prima facie* case of falsehood be made out, she will be bound to show that the assertions were made under a belief in their truth.◊ A lady once had a young woman in her employ, who was afterward dismissed. Having a chance to make another engagement, she referred to her former mistress, who wrote to the person making inquiry: "I parted with her on account of her incompetency, and not being lady-like nor good-tempered. P. S.—May I trouble you to tell her that, this being the third time I have been referred to, I beg to decline any more applications?" The result could have been foreseen. The girl lost the engagement. Stung by the letter, she sued the writer, and general evidence was given of her competency, lady-like manners, and good temper, and that, in reply to the two previous applications which were made before her dismissal, the writer had recommended her. It did not appear in evidence why she was dismissed. The judge told the jury that they must decide whether there was sufficient proof that the defendant, in writing the letter, had been influenced by some improper feeling toward the plaintiff to make a false statement knowingly. They found that there was, and the plaintiff got a verdict.

On another occasion a man was asked about the character of a servant who had been in his employ, and he replied that she was dishonest. Of course, she lost the prospective engagement. She sued.

* Starkie, 344. † Starkie, 344. ‡ 30 N. Y., 20. # 1 F. and F., 24.
‖ Burr, 2425. △ 3 Q. B., 11. ◊ 3 Q. B., 5; 109 Mass., 193.

It appeared from the evidence that the charge of stealing was not made until after she had left the defendant's service; that he had told her he would say nothing about it if she would resume her employment at his house, and that he afterward said to her that, if she would admit the theft, he would give her a character. The jury concluded that he was not acting *bona fide* in the reply he gave to the inquiry as to the girl's character, and gave her a verdict.*

In making a damaging statement to an inquiring person about a domestic, it is perhaps kinder to her to see that no one is present but the one interested in the inquiry. It may also turn out to be the safer course to pursue. It is true that such caution is not absolutely essential for the protection of the communication, but, if an opportunity is sought for making a charge before third persons when it might have been made in private, it affords strong evidence of a malicious intention, and thus deprives it of that immunity which the law allows to such a statement when made honestly; and, too, the fact that a third person is present is a circumstance which, taken in connection with others, such as the style and character of the language used, would have weight with a jury in determining whether the person making the statement had acted in good faith or had been influenced by malice.† The same thing may be said of an accusation made to a servant in the presence of another. It is a question for the jury. If it is made at such a time, on such an occasion, and under such circumstances that the inference of malice *prima facie* arising from the accusation is rebutted, the burden of showing that it was actuated by malice or ill-will rests upon the servant. It must, for instance, be made in good faith and for a justifiable purpose, in the discharge of a duty, public or private, legal or moral, or in the prosecution of one's own rights and interests, and without any design to defame the person to whom it relates, even though it is all untrue.‡ Thus, if a lady is about to discharge a servant, and calls in a third person to hear the reason therefor, and states the reason in that person's presence, the courts have held that such a communication made with honesty of purpose is privileged.# It has been held, however, in Massachusetts, that a false charge made before a third person is libelous.‖ If the statement is made in answer to inquiries, it must be to some person who has an interest in the inquiry, and not as mere matter of gossip.^ So, where a gentleman, having dismissed his servant for dishonesty, refused to give him a character, alleging to those who applied that he had dismissed him from his service for dishonesty, and the servant's brother afterward inquired of the master why he had so treated the servant, and was thus keeping him out of a situation, the gentleman replied, "He has robbed me, and I believe for years past."

* 16 C. B. N. S., 829.
# 16 Q. B., 322.
† 109 Mass., 193.
‖ 109 Mass., 193.
‡ 3 How. (U. S.), 266.
^ 1 C. M. and R., 181.

Only one instance of robbery had been charged or proved, but it was held, nevertheless, that the answer to the brother was privileged.*

It seems, too, that it is within the scope of privileged communications to honestly protect one's interest by informing servants of the dishonesty of a fellow-servant. A man, having dismissed his servant, afterward remarked to two other servants: "I discharged that man for robbing me; he is a thief, and if ever you speak to him again or have anything to do with him I shall consider you as bad as him, and shall discharge you." This was held on a subsequent trial to be a privileged communication.

Let us now look at another right. Servants have well-defined rights in regard to wages. If they perform their part of the contract, they are entitled to a performance on the part of the party of the first part, to wit, the party hiring. Just what the servant has to do has been succinctly stated by Mr. Story: "A servant," says he, "is bound to obey all the just and reasonable commands of his master, to be careful and faithful as to all property committed to his charge, to do with diligence and care his proper and appointed work, and to behave with decency and in a manner consistent with his station as servant. . . . But the command must be just and reasonable, and within the fair scope of his employment." †

The right to the wages is not affected by the fact that there is nothing for her to do, if she is on hand and holds herself ready to serve.‡ The hiring being an accomplished fact, and the time of service begun, the right to wages exists. If there is nothing to do, so much the luckier for the servant. As a matter of fact, however, it may be safely said that such an easy state of affairs seldom occurs in the experience of most domestics.

The right to wages is unaffected also by damage done by the servant. For instance, if she injure articles or lose them in the course of the service, the party hiring can not without a specific agreement to such effect, deduct from the servant's wages their value, but must bring her cross-action against the servant for compensation.# So that, if a lady deducts for some such cause a portion of her cook's wages, the cook would have a perfect right to sue for the sum deducted. Inasmuch, however, as the party hiring can bring a cross-action, or, as in New York practice, set up a counter-claim in the cook's action, for the lost articles, the cook's net recovery would be *nil*. In other words, the legal and illegal ways of settling for the damaged or lost articles end in similar results. "It is six of one and half a dozen of the other." As a matter of practice and advisability, the illegal method of deduction, although it overrides the servant's rights, is better for her, as it saves her the expense of a lawsuit merely for a principle. The wise

* 16 Q. B., 322. † 2 Story on Contr., § 1,304. ‡ 32 Barb., 564.
# 2 Story on Contr., § 1,297.

cook will not grumble at it. She, if anybody, ought to know that the frying-pan is better than the fire.

Nor can the party hiring deduct from the servant's wages any sum paid a physician called in by the hirer for the servant without the request or consent of the latter, nor in this case can a cross-action be brought for such sum, as the act is considered as merely one of generosity.*

If a servant hired for a specific time is wrongfully discharged before the expiration of the time for which she was hired, she can sue the party hiring for a breach of contract. She can bring an action either to recover for the services that she has actually rendered or for damages for the breach, in which latter case she can recover any amount already due her for services, and also compensation for damages sustained by the wrongful dismissal.† She can not wait, however, until the expiration of the period for which she was hired, and then sue for the whole wages on the ground of a constructive service.† It is obligatory upon her to diligently try to find another place. She must make reasonable exertions to diminish the damages. This is an *active duty* which the law wisely imposes. "Public interest and sound morality accord with the law in demanding this, and if the injured party through negligence or willfulness allows the damages to be unnecessarily enhanced, the increased loss falls upon him, and he can recover nothing for damages which by reasonable diligence on his part could have been prevented."‡ If the servant has been unable to find employment, and has been forced into involuntary idleness by circumstances, her damages will be an amount equal to the whole compensation agreed upon. This was held in a case where the action did not happen to be brought until the time of hiring had expired.* In another case where a servant who had been hired for two months was discharged without cause at the end of five days, it was held that the servant was entitled to recover the wages for the whole two months, although there had been so few days' service.‖

If, now, on the other hand, the servant hired for a specific time is justly dismissed, or without reasonable cause leaves the service, what are her rights in regard to wages? Chancellor Kent says that in such case she loses her right to wages for the period she served.^ This is, undoubtedly, the rule where the full performance of the contract is a condition precedent to the right to wages, and through the servant's fault fulfillment becomes out of the question. Common sense and strict justice, however, lead to a different rule where the fulfillment of the contract is prevented or rendered impossible by the sickness or death of the servant. The law makes a distinction between the willful or negligent violation of a contract and where its fulfillment is prevented by the act of God. "In the one case, the application of

* 2 Story on Contr., § 1,297.
* 1 E. D. Smith, 70.
† 4 Daly, 401.
‖ 26 How. Pr., 528.
‡ 28 New York, 76.
^ 2 Kent, p. 292.

the rule operates as a punishment to persons wantonly guilty of the breach, and tends to preserve the contract inviolable. In the other case, its exception is calculated to protect the right of the unfortunate and honest man who is providentially and without fault on his part prevented from a full performance."* In general, the contract is subject to the implied condition of health and strength, and sickness will excuse a servant from liability, and justify her in rescinding the agreement.†

Such are some of the rules regarding the rights to wages of servants who are hired for a specific time. With those who are not hired for any particular time, as is the case with the majority of domestic servants, the case is different. The servant is considered as hired with reference to the general understanding that she shall be entitled to her wages for the time she serves, and either party, in the absence of any agreement to the contrary, may determine the service at any time.‡ The question most likely to arise on such termination is whether any notice must be given by the party terminating the service. In England, a month's notice is customary, and, if it is the hirer who ends the hiring, he can give a month's wages instead of the notice. If the dismissal is for misconduct, however, the servant is not entitled to the month's wages.# The English rule has not been incorporated in the law of this country. As was stated by Chancellor Kent, there is no distinction between menial and other servants. Whether notice is to be given depends upon the contract between the parties, or, if that is silent on the subject, it depends upon the custom of the particular place. Where there is an express contract upon the subject, it is binding, and must be observed, except in case of the disobedience of the servant, or under some other such circumstances. If the parties have not seen fit to take the subject of notice into consideration, no notice is required unless a well-established custom to give notice exists.‖

Before closing the discussion of the right to wages, mention should be made of an exception to the rule that the servant who performs faithfully her contract without breach is entitled to wages. The exception is that of persons whom the law deems unable to contract. Take the case of a married woman, for example. Where the common law still controls the relation of husband and wife, all wages the wife earns belong absolutely to him, and any promise made to pay her is considered as a promise made to him. And the common-law rule prevails except where it has been modified or changed by statute. In New York State, before 1860, a married woman who contracted for her personal services with the knowledge and consent of her husband, and was promised by the party hiring what her services were reasonably worth, acquired no title to her earnings in her own right.△ It

* 20 N. Y., 197. † 2 Story on Contr., § 1,303. ‡ Shars. Black., 426, n.
# Cooley's Black., p. 129, n. ‖ Shars. Black., 420, n. △ 42 Barb., 66.

was hard upon a poor wife, and the Legislature gallantly enlarged the rights of married women, so as to enable them to contract for their services, and receive and keep the pay for them for their sole and separate use, and to invest the same.*

Then take the case of minor servants. In general, a child's earnings belong to and are recoverable in the name of the parent. In the absence of an agreement, express or implied, that payment may be made to the child, the parent alone is entitled to the child's earnings.† The father, if living, can claim his child's wages; but, if he be dead, they belong to the widow so long as she remains unmarried.‡ The law puts upon her the support of the children, and so, if they go out to service while under age, gives her the right to their earnings, and to collect them. But if she marries again—presto!—her legal capacity is gone. She is no longer herself, but has merged her identity in another, and she can no longer control the property or earnings of her children.*

If in general there is an express or implied agreement that the child may receive the wages, that agreement supersedes the common-law rule. For instance, if a minor makes a contract for her services on her own account, and the father knows of it and makes no objection, there is an implied assent that she shall have her own earnings.‖ If, again, the parent resides in the same place, and neither receives nor claims any wages for the daughter's services for a long period, the inference would be strong that he or she intended that the daughter should receive her own earnings. Or, if the parent is absent for several years, and leaves the child to shift for itself, the presumption is that there was an intention to emancipate the child.^ In New York State the Legislature has taken a hand in this matter, and provided that payment of wages to a minor in service shall be valid unless the parents or guardians of such child notify the party employing the minor within thirty days after the service begins that they claim the child's wages.◊ And, under any circumstances, if it appears that the child at service has no parent or guardian entitled to her wages, the mistress must pay them to the servant.‡

Such are some of the rights of those who serve us. It would be a difficult task in the limits of a magazine article to treat of all their rights. Being human beings, and performing their lowly duties by contract only, the law clothes them with rights similar to those possessed by other persons, who are not compelled to undertake what we call menial work. Their property rights, for instance, are as sacred as those of princes. To steal a dollar from a cook is as wrong as to break open the safe of a banker. Their rights of life and limb also are just as inviolable as those of their employers. To kill a waitress is murder as well as when a queen is put to death violently. To chew up the

* L. 1860. † 5 Wend., 204. ‡ 5 Lans., 339. * 5 Barb., 122.
‖ 10 Barb., 300. ^ 8 Cow., 84. ◊ L. 1850. ‡ 29 Barb., 160.

thumb of a chamber-maid is mayhem just as surely as if it were the thumb of the President.

And so we might go on enumerating their rights in general, but the purpose of this article has been attained—to point out some of the rights of servants more or less peculiar to their calling in life, in the hope that a due recognition of them by those whom fortune has placed on a higher social pedestal will contribute a little to mitigate the worst evil of housekeeping. That it will eradicate the evil, or even be a panacea for half the attendant woes, is not for a moment claimed or expected. There are too many other independent elements at work to keep up the evil. But as each single drop of water falling on the stone helps to wear it away, so the observance of one form of relief will do its little toward wearing away the trouble which began with Hagar, and will end—Heaven only knows when.

## THE NEW YORK GEOLOGICAL SURVEY.*

By JAMES HALL, LL. D., State Geologist.

THE history of the Geological Survey of New York from 1835, when the Legislature passed a resolution requesting the Secretary of State to report a plan for a geological survey of the State, is very easily traced, through the public documents and published reports made since that period. The events preceding, and which led to that action of the Legislature, are, however, of great interest and importance, and would of themselves form a very interesting chapter in the history of scientific progress in the State of New York, and of the country at large.

The mineral resources of the State had been the subject of discussion and inquiry even during the period of the Revolution; and, soon after the conclusion of peace, societies were formed for the purpose of continuing these investigations, but so little of scientific knowledge was at that time possessed that no systematic progress could be made in this direction. The gradual but constantly increasing interest in agriculture and the arts stimulated inquiry, and there were not wanting men of intelligence, wealth, and position to foster and encourage such investigations.

These indirect influences, which resulted in shaping public opinion and making a geological survey possible, were for many years quietly in operation; and the Society for the Promotion of Agriculture, Arts, and Manufactures, afterward the Society for the Promotion of Useful Arts, instituted in the city of New York in 1791, laid the foundation of scientific inquiry in the State, and its transactions afforded the

* From advance sheets of "The Public Service of the State of New York."

means of communication between the more intelligent people of the State upon all subjects embraced in its title. Chancellor Robert R. Livingston was the president of this society from its formation till the time of his death, in 1813; and the first volume of the Transactions (1791 to 1799) contains no less than eighteen communications from his pen upon various subjects.

The Annual Address for 1813 was delivered before the Society for the Promotion of Useful Arts, at the Capitol, in Albany, by Dr. Theodoric Romeyn Beck. In the preface to this address he stated that his aim in composing the address had been a special one. "It was to exhibit at one view the mineral riches of the United States, with their various application to the arts, and to demonstrate the practicability of the increase of different manufactures, whose materials are derived from this source."

The most notable and important movement in the progress of scientific study began about 1817, when Professor Amos Eaton, after having prepared himself at Yale College with the best means and instruction then afforded, began his courses of scientific lectures at Williams College, which he afterward extended to the larger towns of New England and New York. In 1818, at the invitation of Governor De Witt Clinton, who was ever a most enlightened and liberal advocate of scientific progress, Professor Eaton gave a course of lectures before the New York Legislature, some of whose members had already been his pupils. At this time much interest was awakened in the subjects of geology and other departments of natural history throughout the State. Professor Eaton's lectures in Troy led to the organization of the Troy Lyceum of Natural History, which at that time could boast of possessing a more extensive collection of geological specimens than could be found in any other institution within the State of New York. In 1820 and 1821 Professor Eaton, with the assistance of Drs. T. Romeyn and Lewis C. Beck, under the patronage of Hon. Stephen Van Rensselaer, carried out an agricultural and geological survey of Rensselaer and Albany Counties. These surveys, reports of which were published, were intended to be made subservient to the interests of agriculture, and were spoken of in the "American Journal of Science" as being the most extensive and systematic efforts of the kind made up to that period. In 1822, under the patronage of Hon. Stephen Van Rensselaer, Mr. Eaton undertook a geological and agricultural survey of the district adjoining the Erie Canal. The report upon this work was published in 1824, in a volume of one hundred and sixty-three pages, with a geological profile extending from the Atlantic to Lake Erie, and a "profile of rocks crossing part of Massachusetts" (from Boston Harbor to Plainfield), by Rev. Edward Hitchcock, who also furnished a description of the rocks and minerals crossed by this profile. In 1824 General Van Rensselaer established the Rensselaer School in Troy, and its graduates became efficient aids in the dissemination of

scientific knowledge and in the cultivation of those scientific tastes which pervaded all the better classes of communities for many years. Much had already been done, therefore, to prepare the way, and the public mind was fully awake to the interests and importance of a geological survey, when the Albany Institute, in 1834, memorialized the Legislature for some action in that direction.*

These memorials were referred to a committee of the Legislature, who recommended a resolution by which the Secretary of State was "requested to report to the Legislature at its next session the most expedient method of obtaining a complete geological survey of the State, which shall furnish a scientific and perfect account of its rocks, soils, and minerals, and of their localities; a list of all its mineralogical, botanical, and zoölogical productions, and provide for procuring and preserving specimens of the same; together with an estimate of the expenses which may attend the prosecution of the design, and of the cost of publication of an edition of three thousand copies of the report, drawings, and geological map of the results."

In pursuance of the request contained in this resolution, the Secretary of State, Hon. John A. Dix, presented a report at the following session of the Legislature, which contained much valuable information with reference to what had already been done toward developing the mineral resources of the State, giving a summary of our knowledge of the subject at that time, and discussing several questions of great interest; for example, the salt and salt-bearing formations, our mineral springs, and the probabilities of finding coal within the limits of the State. He also gave a statement of what had been done in other States, and of work in a similar direction elsewhere in progress or in contemplation.

Under their distinctive heads he discussed the botany and zoölogy of the State, and gave reasons why each one should receive due attention. Under the head of Zoölogy the subject was treated under the following subdivisions: Quadrupeds, Birds, Fishes, Testacea,† Zoöphytes, etc., and lastly the Insects.

The report concluded with the recommendation of a plan for the Geological Survey by a subdivision of the State into four districts,‡

* Senate Document No. 15, 1834.

† Under this head the Secretary of State said: "Our shells, whether of marine, lake, river, or land production, deserve a very critical examination, more especially as the fossil remains of this extensive tribe of animals, both of living and extinct species, are considered as affording the most certain criteria for determining the priority of existing geological formations in the order of time. There is no department of our natural history which, for scientific purposes, requires more careful investigation. Specimens should be preserved for systematic classification and arrangement; and it is by no means improbable that these collections, with the fossil specimens, which may be found imbedded in our rocks and soils, will be instrumental in showing the identity of formations here and in the Old World, which have hitherto been considered entirely different in their geological character."

‡ The First District consisted of the counties of Suffolk, Queens, Kings, Richmond,

which plan, with some modifications, was carried out in the final organization. This plan contemplated the employment of two geologists for each district, which was modified to the appointment of one geologist and an assistant for each district. One mineralogist was appointed for the entire State, and also one botanist and one zoölogist.

During the session of 1836 the Legislature passed "an act to provide for a Geological Survey of the State," authorizing and directing the Governor to employ a suitable number of competent persons, whose duty it shall be, under his direction, to make an accurate and complete geological survey of this State, which shall be accompanied with proper maps and diagrams, and furnish a full and scientific description of its rocks, soils, and minerals, and of its botanical and zoological productions, together with specimens of the same; which maps, diagrams, and specimens shall be deposited in the State Library; and similar specimens shall be deposited in such of the literary institutions of this State as the Secretary of State shall direct.*

The act further provided for an annual appropriation for defraying the expenses, and required the persons employed to make an annual report to the Legislature on or before the first day of February in each year, setting forth the progress made in the survey.

The magnitude and importance of the work were duly considered by Governor Marcy and his advisers,† and the appointments were made only after long deliberation, and extensive correspondence with the prominent scientific men of the country, and with the Governors of other States.

The appointments of the principal geologists were made as follows: Lieutenant W. W. Mather, a native of Connecticut, who had lately resigned from the United States Army, was assigned to the First Dis-

New York, Westchester, Rockland, Putnam, Dutchess, Orange, Sullivan, Delaware, Ulster, Greene, Columbia, Rensselaer, Albany, Schoharie, Schenectady, Saratoga, and Washington, containing an area of 12,263 square miles

The Second District consisted of the counties of Warren, Essex, Clinton, Franklin, Hamilton, and St. Lawrence, to which was afterward added the county of Jefferson, making 10,817 square miles.

The Third District comprised the counties of Montgomery, Herkimer, Oneida, Lewis, Jefferson (afterward added to the Second District), Oswego, Madison, Onondaga, Cayuga, Wayne, Ontario, Monroe, Orleans, Genesee, and Livingston, making, as reorganized, 11,468 square miles.

The Fourth District consisted of the counties of Otsego, Chenango, Broome, Tioga, Cortland, Tompkins, Seneca, Yates, Steuben, Allegany, Cattaraugus, Chautauqua, Erie and Niagara, embracing an area of 11,594 square miles.

The Third and Fourth Districts were afterward reorganized, making all the counties to the west of Cayuga Lake, and a line drawn north and south from its two extremities, the Fourth District, which contained 11,060 square miles.

* Laws of fifty-ninth session, chapter 142.

† Among these gentlemen were Hon. John A. Dix, Secretary of State, Hon. Stephen Van Rensselaer, Dr. T. Romeyn Beck, Professor Amos Eaton, and Edwin Croswell, Esq., who had frequent meetings, which were continued at intervals through several months.

trict; Professor Ebenezer Emmons, of Williams College, was assigned to the Second District; Mr. T. A. Conrad, of Philadelphia, was assigned to the Third District; and Mr. Lardner Vanuxen, of Bristol, Pennsylvania, to the Fourth District.*

The mineralogical department was assigned to Dr. Lewis C. Beck, a native of Albany, but at that time a Professor in Rutgers College, New Jersey. Dr. John Torrey, of New York city, was commissioned as State Botanist, and Dr. James E. De Kay, of Long Island, as State Zoölogist.

The assistants in the geological department commissioned by the Governor were, Caleb Briggs in the First Geological District, James Hall in the Second, George W. Boyd in the Third, and James Eights in the Fourth District.

The instructions given to these officers were essentially the same as recommended in the report of the Secretary of State. Each of the geologists was required to collect, in his own district, eight suites of rock specimens, but no conditions of this kind were imposed upon the mineralogist, botanist, or zoölogist. A special draughtsman was appointed for the zoölogical department and also for the botanical department. The geologists were each allowed a small sum ($300) annually to pay for drawings of sections, maps, etc., which might be required for the illustration of their reports.

This, in brief, was the organization of the Geological Survey at its commencement. At the end of the first year, it became evident to the geologists that the relations of the rock formations, the age and order of superposition, among the then unknown, or very imperfectly understood, stratified deposits, could only be determined on paleontological evidence. They therefore unanimously recommended to the Governor that some competent person be appointed to devote himself to that department. To this position Mr. Conrad was assigned, thus leaving a vacancy in the Third Geological District, which, after a reorganization of its boundaries, as before explained, was assigned to the charge of Mr. Vanuxem, and Mr. Hall was appointed to the Fourth District.

As had been suggested in the report of the Secretary of State, the scientific staff assembled each year, and sometimes twice a year, in spring and in autumn, at the Capitol, to compare notes and observations, to agree upon methods of work, and to receive suggestions from the Governor. These meetings became more important and even essential to the geologists, since they soon found themselves dealing

* It will be seen that neither of the principal geologists was a native or resident of the State of New York, though Lieutenant Mather had previously been instructor in the Natural Sciences in the Military Academy at West Point. Nor should it be forgotten that no inquiry was ever made regarding the political opinions of these gentlemen, and it proved that, of the seven principals of departments thus appointed, six were in political opposition to Governor Marcy.

with a series of rocks which, up to that time, had received no full elucidation in any country; hence the necessity of comparing observations and views, with the purpose of agreeing upon some common terms of designation became apparent, and very soon, imperative. The comparison of observations and interchange of views led to the opening of correspondence, by a formal resolution of the New York Board, with other geologists, especially with those engaged in State surveys, of which several were then in progress. This correspondence led to an agreement for a meeting of geologists in Philadelphia in the spring of 1840, and this assemblage of less than a score of persons led to the organization of the American Association of Geologists, which, at a later period, on the occasion of its third meeting, added the term Naturalists; and finally, by expanding its title, it became the American Association for the Advancement of Science. It is due to the State of New York that these facts appear in this connection, and it is but fair to state that her geologists have contributed largely to the subjects of discussion and to the array of new facts which have been brought before the scientific world through the agency of this organization.

During the few years of field work, the New York geologists had harmonized the conflicting views before entertained regarding the relations of the geology of the eastern and western parts of the State; they had traced the boundaries of the successive geological formations; had shown the extent and limits of the iron-bearing strata, and had rectified the erroneous views which had been held till some time after the commencement of the survey, regarding the boundaries and distribution of the salt-bearing formation of the State. They had, also, shown the limits of the granitic formations, and their associated mineral products; the thickness and extent of all the limestone, sandstone, and shale formations of the State, and had definitely settled the relations of the rocks of New York to the coal-measures of Pennsylvania and the geological formations of the Western States.

Their labors had in a great degree quieted the feverish anxiety regarding the discovery of coal within the limits of New York, for which frequent explorations had been made in the black slates of the Hudson River Valley and elsewhere, involving the expenditure of much money and loss of time.* A rational idea of the general geological structure, and the relations of the geological formations of the State, had been acquired by the intelligent population, through the annual reports of the survey, which presented the results of each season's work in the field.

* Professor Mather has estimated, from what he regarded as reliable data, that the fruitless coal-mining enterprises which had been undertaken in the Hudson Valley alone, during the fifty years preceding 1840, had cost more than a quarter of a million of dollars. The sums thus expended in other parts of the State, though doubtless much less, must, nevertheless, have been very large.

During these years the New York geologists had accumulated a vast amount of material and of facts regarding the geological formations within the State, proving conclusively that they could not be parallelized with any of the described and well-determined formations of Europe. The Silurian system of Murchison, as described and illustrated in the "Edinburgh Review," in 1838, and as finally published in 1839, although covering a portion of similar ground, was not broad enough to meet the requirements of the geology of New York. Thus failing to find the means of comparison and identification, the term "New York System" was proposed, to embrace the sedimentary formations from the Potsdam sandstone to the base of the carboniferous system; or, as the formations were developed in New York and southerly into Pennsylvania, the upward extension of this term reached to the base of the coal-measures.* This term, "New York System," includes the formations ordinarily embraced in the names Cambrian, Silurian, and Devonian of England and the Continent of Europe. The geological series in New York is so complete that the succession leaves no lines or breaks for the establishment of "systems," the whole being but a single system; and had the older rocks of the globe been first studied in this State, no such terms or subdivisions would ever have found their way into geological nomenclature. The strongest line of demarkation, however, or the most marked interruption of continuity in the succession, occurs at the termination of the Hudson River group, where a great conglomerate or a heavy-bedded and well-marked sandstone terminates the physical and biological conditions of the preceding period. This break in the continuity, which is the proposed limit of the Cambrian system, is, however, only of local importance.

Since there was no possibility of identifying the individual rocks and groups of strata with those of Europe, as described, the New York geologists were compelled to give names to the different members of the series; and since the sandstones, limestones, slates, and shales are so similar in different and successive groups, it was impossible to give descriptive names which would discriminate the one from the other. Therefore, local names were proposed and adopted, as, for example: Potsdam sandstone, Trenton limestone, Niagara limestone, and Niagara shale (the two latter, with subordinate beds, making the Niagara group), the Medina sandstone, the Onondaga salt group,† the Hamilton, Portage, and Chemung groups, thus giving typical localities of the rock instead of descriptive names. This method or system

* In Southern New York and adjacent Pennsylvania the highest member of the New York system is the Upper Catskill gray sandstone and conglomerate. The rocks pertaining to the coal-measures supervene, without the presence of the great carboniferous limestone and associated strata of this age in the States of the West and bordering the Mississippi Valley.

† The term "Onondaga salt group" was regarded as objectionable on account of its length, and the term Salina was not adopted simply because the rocks of the formation or group are not visible nor accessible in the town of Salina.

of nomenclature leaves no possibility of mistake or confusion which might arise from a different appreciation of descriptive terms. The typical locality always remains for study, comparison, and reference, and there need be no difference of opinion or discussion as to what was intended by the use of any one of the terms. The progress of geological science in the country is greatly indebted to this system of nomenclature, and to the absolute working out of the succession of the groups, and the members of the same, to which this system of nomenclature has been applied.

At the final meeting of the Geological Board the adoption of the term "New York System" was considered imperative, because of the impossibility of harmonizing the formations here known with those of Europe. In the adoption of the names of rocks and groups—the nomenclature as now known—there was scarcely a dissenting voice, and the names as then adopted were published in the final reports, and have become the nomenclature of the science in America.

As the field-work of the survey approached completion, the question of publication became a matter of deep interest to every one connected with the work. The incumbents in each one of the departments were desirous of publishing their work in octavo, that the results of the survey might appear in a convenient form, and become hand-books for students in science. This plan, however, was overruled by Governor Seward and his advisers, who considered it due to the dignity and importance of the State of New York that the volumes should be published in quarto form, especially as they were to be presented to other States and foreign governments as emblematical of the greatness of the State. Governor Seward himself wrote an introduction of nearly two hundred pages to the first published volume of the work (Zoölogy—Mammalia) in 1842. This volume was followed by others in the same year. The geological reports were all completed in 1843, and the last volume of Zoölogy, that upon the birds of the State, by Dr. De Kay, was published in 1844.*

In 1842 Mr. Conrad resigned his position as paleontologist of the survey without communicating any report to the Governor, and the four geologists who had expected to avail themselves of the results of his investigations were left to their own resources. In this state of affairs each one of the geologists illustrated his own report, as best he could, by figures of characteristic fossils of the rocks and groups which he had studied in his own district. By this means a very considerable number of the more common and characteristic fossils were illustrated in woodcuts, which were printed in the text, thus giving authentic guides for the determination of all the more important members of the series.

* The work thus completed embraced the following subjects: botany, two quarto volumes; zoölogy, five quarto volumes; mineralogy, one quarto volume; geology, four quarto volumes, of each and all of which three thousand copies were published.

The incompleteness of the contemplated Natural History of the State was recognized by the Governor and Legislature, and it was also claimed that agricultural interests had not been sufficiently considered in the work already published. It was, therefore, determined that the department of paleontology should be re-established, and that of agriculture be added to the plan of the work. Under the latter title Dr. Emmons published five volumes; the first being devoted to the general relations of the topography and geology of the State to its agriculture and agricultural products; the second, to the chemical analysis of the soils and agricultural products, with extended observations upon the temperature of the air, soil, etc.; the third and fourth (text and plates), to the description and illustration of the cultivated fruits of the State; and the fifth, to insects, chiefly those injurious to vegetation.*

The paleontology was committed to Mr. James Hall, who entered upon the work in 1844.† Volumes one and two had been substantially completed and the third considerably advanced, when, in 1850, further appropriations were withheld and the work virtually suspended. In 1855, through the influence of the Hon. E. W. Leavenworth, Secretary of State, the work was revived and a plan for its completion proposed. A provision was also inserted that an appropriation from the State for the collection of fossils should be made annually for eight years. Through this means large collections were made and a great amount of new material added to that previously obtained, and this necessarily and unavoidably expanded the work much beyond what was originally contemplated, and beyond what could have been expected before such collections were made.

At the present time, five volumes of the Paleontology have been published, two of which were bound in two parts, making the entire number of seven bound volumes. These volumes contain about twenty-seven hundred pages of text and five hundred and sixteen plates. At the time of this writing the work has been virtually suspended for the past two years, with one hundred and seventy-five plates already lithographed and printed, and more than sixteen hundred pages of manuscript ready for the printer, besides drawings for more than one hundred and twenty-five plates.‡

* Many of the results obtained by the late Dr. Fitch, of Salem, New York, and by Dr. Harris, of Cambridge, are incorporated in this volume.

† The work was begun almost without collections of fossils of any kind, without a library for reference, without artists or any of the appliances or resources considered necessary in scientific investigation and illustration. It became necessary to create the department from the beginning. No appropriations of money were made by the State for the collection of fossils until 1856, and this burden of labor and expense bore heavily upon the author of the work.

‡ No printing has been done for three years (since 1879), and no lithographic work for about two years. The delays in the publication of the volumes during the past are not chargeable to the author. The work was virtually suspended from 1850 to 1856.

Up to the present time the entire publication of the Natural History of the State, exclusive of the Annual Reports of the Survey and thirty-five Annual Reports of the State Museum, may be enumerated as below:

| | | | |
|---|---|---|---|
| Botany, in two volumes | bound in | 2 | volumes. |
| Zoölogy | " | 5 | " |
| Mineralogy | " | 1 | " |
| Geology | " | 4 | " |
| Agriculture | " | 5 | " |
| Paleontology, five volumes | " | 7 | " |
| | | 24 | volumes. |

Of these twenty-four volumes, three thousand copies each have been published, making the entire number of seventy-two thousand quarto volumes, which have been published and distributed as the result of the Geological Survey of the State.

At the close of the field-work of the survey, the question of the disposition of the collections which had been made became a subject of much interest. It had been originally suggested that these might occupy a room in the State Library, or be arranged in some of the unused committee-rooms in the Capitol. The amount of material, however, was so great, and the importance of its proper arrangement so manifest, that the old State Hall, at that time about to be vacated, was appropriated for the purpose of a State Museum. At a later period (1857) the old building was demolished, and a more commodious one erected on the same site; and this is now filled to overflowing, and a large amount of collections remain unprovided for. In nearly all respects the survey has been carried out according to the original conception and plan. It has resulted in far larger and more interesting collections, and in far more interesting and valuable publications, than could ever have been anticipated by its original promoters. It has laid the foundations of geological science in our country, and made the State of New York the classic ground for the study of palæozoic geology.

The cost of the survey being computed in dollars, the value of the results is sometimes estimated by a similar standard; but the peo-

Great delay occurred in the completion of the plates of volume three after the text had been printed. The fourth volume was greatly delayed, both in the printing of the text and the lithography of the plates, owing to the enhanced price of all materials and labor during the war; and for the same reason very little progress was made with the fifth volume until a modification of the printing contract was made in 1871, which enabled the printer to go on with the work. Fully four years were lost on this account. The manuscript for volume five was, according to contract, deposited in the State Library in 1866, but after these years of delay it became necessary to revise and expand the same to include new material, which had been obtained and investigated during this interval. In the end, therefore, it became necessary to make two parts of this volume, one of which has already been published, and the other has been for three years ready for printing.

ple of the State of New York might with equal propriety measure the value of the common-school system by the commercial value of their school-houses and grounds. The absurdity would be equally as great in the one as in the other case. Like the system of public education, the results of the Geological Survey have penetrated into every school district and into every corner of the State; and these results are not to be measured by the figures representing dollars, but by the increased intelligence of the people, and the proud satisfaction that we have been able to lay broad and deep the foundations of geological science in the soil of a people whose motto is "Excelsior."

## ORIGIN OF THE CALENDAR AND ASTROLOGY.

By Professor WILLIAM FOESTER,
DIRECTOR OBSERVATORY, BERLIN.*

THE significance of the astronomical portion of the calendar is materially different at present from what it was in the earlier stages of its development. That this may be clearly understood, and the modern problem with which astronomy has to deal in the yearly construction of the calendar justly appreciated, let us examine the history of its origin.

The word "calendar" is derived from *calendium*, denoting the commencements of months, which, in the language of ancient Rome, were called *dies calendæ*, or simply *calendæ;* i. e., days on which "calling out" should occur, from "*calo*," *I call.* This "calling out" took place upon the reappearance of the small crescent after new moon, and at the present day remains the custom among those people who, as for instance the Turks, reckon time wholly from the recurring phases of the moon. This was loudly proclaimed from the roofs of public buildings by appointed priests or seers, who were required to seek for the moon's crescent in the evening sky either two days after new moon, or four or five days after the last appearance of its light in the morning sky; this, then, was established as the beginning of the month, the single days being reckoned by counting backward or forward from the night, or from the intermediate day of full moon. This method of reckoning time from the revolutions and phases of light of the moon has been long practiced in those countries in which the constant clearness of the heavens enables people to determine with considerable accuracy the first appearance of the moonlight, the so-called "new light," and, again, among those whose limited intercourse with other nations afforded no comparison of fixed standards. In

* "Popularische astronomische Mittheilungen." Berlin: Horrwitz & Gossmann. Translated by L. M. Muzzey, B. S.

countries, however, where continued clearness of the sky was not afforded, or where the necessity was urgently felt for a regular determination of future dates, the seers at length desired that they be permitted to calculate, upon the basis of the past determinations of the duration of the regular months, the recurrence of the phases of the moon for a certain time in advance, and therewith the regular succession of the months, and to publicly record the number and the method of counting the days of the single months. Thus, in place of the public proclamation from the house-tops of the observed appearances, the calendar now came into use, containing calculations of the "calling days."

Gradually, however, when after a length of time the new light of the moon failed to appear at the specified date, in consequence of the imperfection of the calendar's determination, the proclaiming was entirely abandoned, and the moon in the calendar became more the standard for reckoning time than the moon in the heavens. It was repeatedly sought to compensate for these variations by revision of the calendar; but the more accurate methods for computing time, which gradually came into general use, soon supplanted the lunar chronology, and the months retained in their duration simply an approximate relation to the lunar month of twenty-nine and a half days, and were finally apportioned as twelve nearly equal divisions of the year.

The solar year, as a great heat-period, naturally attracted the observation of men at an early time, and the knowledge of the recurrence of the same degree of warmth was early recognized as of great importance to the interests and progress of agriculture and navigation. As a period, however, for the reckoning of the days the year was too long, and it was only with the advance of science that it gradually attained to chronological significance, namely, as a large and suitable unit of time for the division into months and days. The recurrence of similar phases of the year and evolution of heat were next associated each time with the appearance of certain celestial phenomena, in like manner as the commencement of the month with the reshining of the moon, and these observations were intrusted to individuals, who either proclaimed or published them. A common yearly calendar was thus prepared in advance, upon the basis of long and careful observations of the times of the recurrence of these phenomena, giving the days of certain months of each year on which they were to be seen, the changes of weather which would then take place, and these days were to form the reckoning points of time.

These phenomena in the heavens from which the data were derived were those positions of the sun in the sky, at certain intervals, relative to some fixed star or constellation, which could be most readily recognized with the naked eye; and, since the light of the sun far supersedes that of the brightest fixed star, these observations could be made

only in the morning or at evening twilight, when it was noticed what bright star was visible near the horizon immediately before sunrise or after sunset. The apparent movement of the sun in the sky made itself manifest from the fact that the stars which were discernible in the western horizon shortly after sunset ceased to be visible after some days, the sun seeming to approach them, and that those observable in the eastern horizon shortly before sunrise gradually remained longer visible in the dawn, the sun appearing to recede from them.

In Egypt, for example, it was noticed that the overflowing of the Nile—which is the result of certain tolerably regular changes in the weather, caused by the position of the sun—always occurred on those days on which the bright light of Sirius was again visible in the morning twilight. In Greece it was likewise observed that those risings and settings of the Pleiades, of Orion, Arcturus, and others, which occurred in the morning or evening twilight, were related to certain yearly variations of heat, and to the directions of great atmospheric currents, and were, therefore, convenient guides in agriculture and navigation.

As the calendar advanced, however, in the predetermination of days and phenomena on which periods of human labor were dependent, the attention of the majority of men was diverted more and more from the direct observation of the moon, the sun, and stars, resting contented with what was stated in the calendar, so that even in the civilization of the present day an evening is accepted as clear if *moonshine* is set down in the almanac. The sun, moon, and stars, together with those other wandering bodies in the heavens, the planets, won a new significance through the origin of astrology, which advances in the following manner with the progress in calendar calculations:

The publication of arranged calendar matter and the constant improvement in the same were owing chiefly to the efforts of wise men, in early Greece, for instance, to the zealous labors of the priesthood at Delphi, who justly esteemed an established calendar a potent element of national unity and order, and as a means of security against the power and influence of those fostering secret teaching. Among other people, as the Romans, the selfish and ignorant priesthood deemed it for their interests to allow such determinations to remain in obscurity, or, on the ground of real or fictitious observations, to regulate the calendar as they desired. In fact, the influence of the seers and priests upon the people would be greatly lessened if the knowledge, which they had acquired of the times of revolution of heavenly bodies and the chronological periods dependent thereon, were to become the property of all; and this loss would be still more augmented, when the unavoidable inaccuracies of these public observations became after a time recognizable, rendering repeated changes in the calendar necessary, or when, in consequence of this, several systems of reckoning time strove for preference.

The difficulty lay chiefly in the fact that the light phases of the

moon and the positions of the sun in the heavens do not recur in a full number of days, and that a solar year does not contain a full number of months; the various phases of the moon requiring a little more than 29½ days, and the positions of the sun somewhat less than 365¼ days; thus making the solar year contain about 12 months and 11 days.

To illustrate: if months of 29 and 30 days be alternated, if 365 days be allotted to each solar year, and after 99 such months (equivalent to eight years), the counting of the months be made from the same date of the year, a tolerable agreement with celestial signs could, indeed, be attained, but after a number of years the date of the month would differ from that indicated by the moon, and with a greater lapse of time the accepted solar year would show a decided variation from the annual position of the sun and moon, and, in fact, from the yearly heating effects of the sun. An improvement could, indeed, be made if, in the alternation of months of 29 and 30 days, two months of 30 days each be allowed to succeed each other at intervals of 33 months; also, if each fourth solar year were to contain 365¼ days instead of 365, and if, finally, once in nineteen years, the so-called golden cycle, the reckoning of the lunar months began with the same date of the sun; but a uniform and perfect coincidence of these cycles of days, months, and years would also, in this manner, be unattainable. In short, the problem was purely an arithmetical one, especially difficult so long as it was sought to make the minor divisions of the year agree with the appearances of the moon, and it is, accordingly, no matter of wonder that many fruitless attempts at improvement were made before a judicious and adequate method was discovered. The founder of Islam clearly recognized the danger which the unsuccessful attempts to construct a calendar for future time engendered for the authority of the leaders in that religion, and hence arose the fear that the unavoidable conflict of different calendars would promote the formation of religious sects. Mohammed forbade, therefore, the establishment of any connection of the lunar month with the solar year, and ordered all calculations to be made from the observation and proclamations of the new light of the moon. While the peculiar difficulties of the chronological problems had afforded, on the one hand, advance in the observation and understanding of the movements of the heavenly bodies, and, on the other, had brought calculations of time into discredit, these astronomical inquiries produced still other important results at an early date, as in Babylon, many centuries before the conquest of Alexander the Great. These results, extending beyond the limits of chronology, secured to astronomers a mighty influence over the minds of the people, notwithstanding the repeated inaccuracies occurring in the calendar. This was attained through the teachings of astrology.

The systematic and long-continued recording of the celestial phe-

nomena had made known, among other things, the cycle of eighteen years, eleven days, in which the lunar eclipses repeat themselves in the same order, and in which there occurs also the possibility of the solar eclipses succeeding each other in nearly the same order. The prediction of eclipses, based upon a knowledge of these periods, and of phenomena which had no such regularity of occurrence as the fundamental chronological ones, and which seemed as frightful disturbances among the heavenly bodies, naturally produced a deep impression, which, in many cases, has been pictured to us, and therefore rendered the knowledge of the stars a peculiarly prophetic wisdom in the eyes of the people. Hence it followed that the development of the solar calendar and its connection with the position of the sun, relative to certain fixed stars and constellations, necessarily produced the conception of a particular influence of the stars upon the destinies of men.

The first appearance of a star in the morning twilight was considered as an indication of important earthly events, of wind and weather, of moisture and dryness, growth and harvest, and its simple position was held, in the popular belief, to be capable of exerting a great variety of influences.

Moreover, the advance made in the knowledge of the stars had also led to more careful investigation of the movements of those five bright stars which, like the sun and moon, changed their position in the heavens, two of them seeming, like companions, to connect themselves with the sun; so that these five planets which, on account of their movements among the stars, seemed nearer the earth than the stellar world, soon came to receive a share of the deification of the sun and moon.

They formed with the latter the sacred number of the seven heavenly powers. This number "seven" is supposed to have led to the division of the interval between two successive changes of the moon, forming the week of seven days. It was hence perfectly natural that the mythical names which the planets soon came to bear, and their positions in the heavens relative to one another and to important fixed stars specified in the calendar, should be regarded as pregnant with meaning, and especially so when the peculiar character of the planet itself, as illustrated in Mars by its striking red light, rendered its deification of increased significance.

Thus, the prediction of eclipses and of other celestial phenomena, as the only means of forecasting future events which had then been attained, the explanation in the calendar of the rising and setting of the stars and the mythical characterization of the planets, were all the fruit of the strong desire in men to lift the veil of the future and of a deep earnest reverence for the lights of heaven, which pursue their eternal and unchanging courses above all earthly mutability.

Another cause of the power which this mighty system of as-

trology continued to exert over the minds of people during so many centuries, and whose traces are still observable in greater or less degree, not only in the minds of the masses, but also in men of acute understanding, is suggested in the pithy remark of Kepler: "The failures of astrological predictions are soon forgotten, because they are of little consequence; their fulfillments are retained with the greatest tenacity; hence, the astrologer remains in veneration."

In fact, such teachings did not receive, at first, unhesitating acceptance; and it was not until individual chance successes were attained, that the belief in the positions of the stars as affecting human destiny found so deep root in inclined minds as to render the prophecies themselves instrumental in bringing to pass predicted events, so that for centuries no doubt to the contrary found popular recognition. When the first teachings of astrology thus founded by the priesthood, and more or less designed to promote its interests, became the possession of philosophers, as of the Greek astronomers of the Alexandrian school, they then gradually assumed a certain scientific character. The force which the moon exerts upon the waters of the earth, in causing the ebb and flow of the tides, was regarded by Ptolemy as chief scientific proof that other heavenly bodies besides the sun exercise a direct influence upon terrestrial life.

Moreover, it was held that the moon exerted a disturbing influence upon sleep, its monthly recurrence affecting the nervous system. On the basis, therefore, of these general predictions, it was then sought to determine the influence upon life and destiny which the various positions of the moon and planets among the constellations of the zodiac exerted, and to discover, partly by astronomical calculation, partly by tradition, what positions the planets had assumed at the time of the birth, as well of striking events in the lives, of distinguished men; or, in general, during the time of a series of important events.

A seeming uniformity in the casual coincidence of celestial phenomena with certain fortunate and unfortunate events was thus derived from this knowledge of the past, and formed the foundation of the methods for forecasting the future.

Naturally, this teaching had to embody a certain number of apparently verified prophecies, which were not derived from conclusions concerning the past, but were purely conceived, or which were associated with the mythical character of individual heavenly divinities.

Thus the planet Saturn, or Cronos, was universally regarded as destroying and harmful, as the powerful, all-consuming god of time whose name he bore; the planet Jupiter, on the contrary, indicated universal fortune, majesty, and beauty.

The planet Mars represented by its omens the dangerous and violent; Venus the mild and pleasant; Mercury the ambiguous and deceptive. Each of the planets had, however, somewhat varying

forebodings, according to the position which it assumed by day or by night in the zodiac or horizon. The twelve signs were assigned to the sun, moon, and planets, as follows: Leo to the sun; Cancer to the moon; and two to each of the five planets—the influence of each of these heavenly bodies being regarded as augmented when it stood in that sign belonging to it, or at points in the other signs which were esteemed peculiarly critical for it.

Thus, the significance of the combined situation of all these bodies received its decisive character from the striking actions of one or more propitious or unpropitious planets, which stood in those positions of increased influence. The so-called horoscope, however, with its derived prognostications concerning the entire future life of the individual, was deduced from that point of the zodiac which appeared in view at the hour of birth. Not only was the planet to whose sign this point in the zodiac belonged the prescribed ruler for life, but also the individual portions of the zodiac, by means of their relations to the single planets, furnished special significations for the horoscope.

The influence of the ruling planet was again essentially modified by the relative positions of the other planets who were entitled to a respectful hearing in the prediction. Indeed, a perfect system finally evolved itself for thus foretelling, from the various situations and aspects at the time of birth, the important events in each year of the life of the newly-born.

In its beginning it possessed much profound thought, since from the positions of the planets at the time of birth, with the aid of their times of revolution, and later, by a theory of all their movements, it could be calculated in advance how they must stand in each year of the individual's life; but the whole soon degenerated into an arbitrary, invented play upon numerical relations. During the lapse of centuries, in which astrology was perfecting and establishing itself in the minds of men, the pre-calculations for the positions of the moon among the planets had been zealously pursued, particularly by the Arabians, and, from the beginning of the fifteenth century, by the people of the Orient. From this period on, these calculations received, aside from their chronological and astrological interest, an augmented importance, on account of the increased demands in naval undertakings and voyages of discovery. The calculations in calendars and ephemerides (in which literature Nuremberg took the lead) were continually amplified, the calendar becoming now concerned with many subjects which grew out of and were nourished by astrological ideas, so that, even at the close of the past century and the commencement of the present, it contained a wonderful mixture of superstitious hints and precepts. These related chiefly to rules of the weather, health, and life; as, for instance, the times favorable for cupping, bleeding, etc. In fact, in many calendars now circulated, there are detailed statements concerning the indications of the planets, etc., and amusing

descriptions as to how children will thrive who are born under such and such signs in the heavens.

Moreover, numerous customs and prejudices still reveal the remains of a belief in the stars; such expressions as "unlucky days" and "numbers," "our stars," "saturnine," "jovial," and the like being firmly implanted in nearly every language.

To the superficial view, the whole system of astrology will appear as a vexatious error of mankind; to the deeper observation, however, there is discernible not only the fund of astronomical knowledge acquired, but also a purer sentiment lying at the basis of all, acknowledging man's dependence upon higher powers.

Indeed, soberly considered, the notion that the heavenly bodies controlled the laws of health, etc., possessed one noteworthy attribute, in that it aided in establishing a belief.

The acceptance of particularly mysterious agencies often rendered efficacious such prescriptions, in consequence of the compulsion which they opposed against human convenience and caprice in requiring fulfillment, thereby effecting a salutary influence which in themselves they did not possess.

We have yet to consider another phase of the calendar's being which has a certain connection with the astrological predictions—namely, the "weather prophecies." Among the most cultured of the ancients the weather was not an object of daily interest and regard to the extent which it has become at the present day. In the regions of Asia, Southern Europe, and Northern Africa, where the weather was at first the most zealously studied, the daily as well as yearly changes of temperature, direction of wind, cloudiness, and precipitation, have a far greater regularity than in our climate.

As Nature there also yields her fruits in greater plenitude, the dependence of universal welfare on the weather phenomena is far less painful and disturbing than in our latitudes. Egypt, only, formed an exception, her harvests being largely dependent upon the overflowings of the Nile; but these would be endangered for only a comparatively short portion of the year.

We have already considered how the first calendars took note of the great yearly changes in the weather from their connection with the rising and setting of bright stars in the morning and evening twilight. As culture, however, slowly penetrated the more northerly regions, which are the chief field of the unremitting conflict between the warm equatorial air-currents and the cold polar currents, and which sections are thereby subjected to incomparably greater changes and uncertainties of weather, it was proved no longer wise to associate such variations with the slow changes in the positions of the sun among the stars. Hence the natural inclination to regard earthly as controlled by celestial influences developed itself into a system of manifold predictions concerning weather phenomena, and accordingly the

most rapidly moving body in the heavens, the moon, was regarded as the most potential ruler of sudden changes.

It was thus always the problem of the calendar-maker, during the middle ages, to prophesy on the basis of observations of celestial influences, and in a lesser degree also upon the weather itself, certain changes in the weather, and the task was nowhere an ungrateful one; for a successful prediction was a foothold for enthusiastic belief in the prophets, and scarcely ever was a failure regarded with much attention.

The belief in the moon's influence upon the weather is still fostered with a tenacity and universality that seem to lend an especial value to specifications in the almanac regarding the so-called "moon's changes." Many have no concern as to the manner in which the "moon's changes" can affect the weather, but follow simply unconsciously the old astrological inclination in ascribing what is doubtful to heavenly influences; others, on the contrary, accept, indeed, without question, the fact of such influence, but construct for themselves a kind of scientific explanation for it.

The moonlight, they say, dissipates the vapors; and, since the moon determines the ebb and flow of the tides, so it causes also an ebb and flow in atmospheric currents, thus affecting the weather. That sounds quite scientific, yet proves nothing. That such an influence is no longer not incontestable, but placed entirely in doubt, careful records are more clearly proving every year.

The Greenwich Observatory, which is especially engaged with observations upon the moon, has recently fully demonstrated, in its observation register of the moon and weather extending over many years, the complete insignificance of the positions and phases of the moon as affecting the condition of the atmosphere; that all so-called "experiences" to the contrary must be regarded as possessing not the slightest value. In fact, such "experience" is a matter peculiar in itself. The human memory of past events is often a very capricious thing, as we have already illustrated in the words of Kepler, and the remembrance of any one who has not learned to systematically collect pure and conclusive "experiences," free from bias and superstition, upon which to base a rational and conscientious judgment, possesses, as a rule, little value. Scientifically arranged facts are also not proof against erroneous conclusions, and it has too often happened that overhasty conclusions in science, which were opposed to the clear views of practical men, have been subsequently destroyed by further scientific inquiry; but in the case now considered the aspect is entirely different. Here the so-called practical men are the visionists, and that pitiful remnant of an ancient false belief now no longer cope with the intrinsic worth, the clear and simple results of coincident measurements and calculations. Let us, therefore, throw into the ruins of astrology all still existing presumption to forecast for any extended

time the character and changes of the weather, and aid, rather, by careful and honest tabulation of meteorological phenomena, in advancing a science whose foundations have already been laid by men of genius, and which in conjunction with the telegraph is furnishing its timely aid to agriculture and navigation. By means of advanced, systematic research into the laws governing the movements of storms, wind, and air-currents, it enables voyages to be made under increased security and rapidity—furnishing information of incalculable value to the navigator.

From the above review of the astrological belief in destiny and weather, let us again revert to our original question: What significance, then, do the present astronomical rules in the calendar possess, and what is the problem therewith associated in popular astronomical instruction? The reckoning of time has almost wholly emancipated itself from astronomical observations. If we simply continue to reckon the days according to our present arrangement of the year, calling each fourth year a leap-year of 366 days, and assign to each hundredth year 365 days—although it ought to be a leap-year, according to the four-year cycle—and again to each four hundredth year 366 days, we shall be certain to remain for thousands of years in such agreement with the sun that we do not need to concern ourselves in the least in the times of his revolution and positions in the heavens. In fact, the calendar is so perfectly arranged and independent in itself that it requires no special assistance from astronomers. The statements regarding the position of the moon in the zodiac and the situations of the planets, and even the exact times of the moon's changes (if we except the significance of these latter respecting the ebb and flow of the tide), no longer possess any value in daily life if we are free from astrological superstition.

Still, there is a persistent clinging to these ideas, and when, some years ago, the Berlin "Astronomical Year-Book" pointed out the insignificance of the moon's influence on the weather, many protests were received from almanac publishers, especially in Poland and Hungary.

Although, as above stated, the popular calendar has become less and less dependent upon astronomy, yet there is evinced an increased interest among people in the yearly astronomical communications. The dependence of ideas and arrangements on the heavenly phenomena is less, but the desire for an understanding and observation of them is much greater. The prediction of eclipses in the almanac might also be omitted but for the probable danger which would arise from sudden frightening of the people; they can not, however, be well omitted, since every one is desirous of observing at the appointed time the more or less remarkable effects of the phenomena, and of bearing a share in testing the accuracy of the times of prediction.

Moreover, life is constantly demanding greater precision, especially

in the measurement of time. The time is not far distant when instruments will be devised for ascertaining in the simplest manner and with the utmost accuracy the time of day from the sun and stars. In general, astronomy will find occasion each year, in ever-increasing measure, to communicate for universal use its advanced determinations and measurements.

The study of astronomy is especially fascinating and helpful to the understanding, in that the mind, translated so far away from the sphere of earth, catches glimpses of the grand and universal outlines of celestial phenomena, and is enabled to emancipate itself from the astrological superstition which we have endeavored to illustrate in the foregoing pages.

## SKETCH OF INCREASE ALLEN LAPHAM, LL. D.

THE advancement of American science has been greatly promoted by the co-operation of a host of earnest workers, who, asking nothing in the way of money profit or fame, but moved by the pure love of science for its own sake, have been satisfied to labor in special or local fields, and contribute of what they could produce as free gifts to the sum of knowledge. Such a man of science was Dr. I. A. Lapham, who, according to a most excellent authority, "would have held a more prominent position if he had been more ambitious"; who was, however, well enough known to the people of his own State and in scientific circles everywhere; and the fitting memorials of whose life-work are conspicuously visible in the organization of the Weather Service of the United States and the prominent position Wisconsin has taken as a region where scientific thought is active.

INCREASE ALLEN LAPHAM was born at Palmyra, New York, March 7, 1811, and died on Lake Oconomowoc, Wisconsin, September 14, 1875. His father was a contractor on public works, which, in the days of the son's youth, were chiefly canals; he built the arches of the first aqueduct at Rochester, and the wood-work of the combined and double locks at Lockport, on the Erie Canal, and was engaged in other important works of a similar character. Young Lapham's earlier tastes were guided largely by the business pursuits of his father. He earned his first money by cutting stone for canal-locks and making plans of the locks for travelers; then he became interested in the minerals that were found in the rock-cuts at Lockport, and was thus directed to the observation of nature. He next appears, in 1826, as an aid to his father, an assistant engineer, in laying out a road down the Canada bank of the Niagara River below the falls; afterward on the Welland Canal; then on the Miami Canal, under Byron Kilbourn; and, during the two years from 1827, on the canal around the falls of the Ohio,

at Louisville, Kentucky. Here his attention was drawn to the study of the luxuriant flora of that favored region, and he began a collection of plants which grew till it numbered about eight thousand species. He also collected the river-shells of the region, and sent several new species to Isaac Lea, of Philadelphia. His first scientific paper was produced in connection with his work here, and was "a Notice of the Louisville and Shippingsport Canal, and of the Geology of the Vicinity," illustrated with plans, geological sections, and a map, and remarkable for containing the first published notice of the occurrence of petroleum in the cavities of limestone rocks. He was next engaged on the Ohio Canal, at Portsmouth, and published in 1832, in the "American Journal of Science," where his former paper had appeared, a second article on the "Geology of Ohio." In the next year he was appointed Secretary of the Ohio State Board of Canal Commissioners, and removed to Columbus, where he continued his scientific studies under the stimulus of improved opportunities; figured as an officer and active member of the Historical and Philosophical Society of Ohio; and served as a member of a committee appointed by the Legislature to investigate and report upon the subject of a geological survey of the State.

In 1836 he removed to Milwaukee, then in the Territory of Michigan, now in the State of Wisconsin, where, or in the neighborhood, he spent the rest of his life, and where he was identified with the birth and development of the scientific interests of the Territory and State. It was his privilege here to play an important part in the institution of security and the settlement of land-titles, the effects of which were undoubtedly felt in the peaceful settlement of the country and the establishment of its society. New-comers found the Territory as yet unorganized, and without any provisions for the purchase or pre-emption of the public lands. Conflicts might easily arise, and the best claims could have no legal title to rest upon. The settlers agreed upon the course they would pursue, and appointed Mr. Lapham a register of claims, to take charge of the records of all entries of land and transfers. Under this system farm improvements were made in confidence, and, when the land-offices were established, the register's records were recognized and acted upon as authentic evidences of pre-emption right. Mr. Lapham performed this service gratuitously.

Mr. Lapham's life was henceforth spent between the conduct of a business that secured him a competency without superabundant wealth, and the scientific study of all that related, or could be of interest to, the Territory and State. In 1838 he printed a catalogue of the plants and shells found in the vicinity of Milwaukee; and in 1844 he published a comprehensive work on Wisconsin which served for a long time as a standard manual of the character and resources of the State and a guide to immigrants. A treatise on the grasses of Wisconsin and the adjacent States, which was published in the first volume of the

"Transactions of the State Agricultural Society," was the forerunner of a suggestion which he made to the Commissioner of Patents (the Hon. Charles Mason), that the agricultural department of his office might appropriately undertake a descriptive catalogue of all the native, naturalized, and cultivated grasses of the United States. An appropriation was obtained from Congress for this object, and Mr. Lapham was invited by the Commissioner of Patents to undertake the work. It was to include the collection of specimens and their arrangement in books for distribution among State societies and agricultural colleges; drawings and enlarged illustrations of the flowers of each species; the collection and distribution of seeds; the preparation of an exhaustive report on each species, and all facts relating to its economic value; and an expedition to the West Indies or South America for the collection of improved varieties of sugar-cane. Several months were spent in the preliminary arrangements for this work; but when the first quarter's account for salary was presented to the Secretary of the Interior, whose indorsement of it was required by law, that officer, who had not recognized Mr. Lapham's appointment, refused to allow it, saying that so useful and responsible a trust should not be conferred upon one whose political sentiments were not, in all respects, in accord with those of the party in power. Mr. Lapham, though disappointed and a thousand dollars poorer for what he had done, went on with his catalogue and completed it so as to include all the grasses of the United States and Territories, so far as they had been previously described and named, with their localities, geographical distribution, time of flowering, etc., which still remains in manuscript. The subject of authorizing this investigation was again favorably considered by President Lincoln's Administration, but any action upon it was prevented by the war.

In 1867 Mr. Lapham, as chairman of a committee appointed under an act of the Legislature of Wisconsin "to ascertain and report upon the injurious effect of clearing land of forests, and the duty of the State in relation to the matter," made a report covering the whole ground of the subject, which was published as a legislative document.

Though particularly interested in botany, Mr. Lapham was active in many other departments of scientific work. In 1847, writing in one of the city papers on the fluctuations in the level of Lake Michigan, he suggested a method for determining whether it had a tide. His observations on the phenomena of the level, begun as early as 1836, were found to be of great practical value in the preparation of plans for river and harbor improvements, and for all works of the cities of Milwaukee and Chicago in any way connected with the lake and rivers emptying into it, and their importance was recognized in Captain (afterward General) Meade's "Report on the Lake Survey" for 1861. On the 3d of September, 1849, he announced, in a paper of the

city, that by a series of observations made every three hours, during the month of August, he had ascertained that there was a slight lunar tide in Lake Michigan. A similar statement was made to the Smithsonian Institution, in connection with the report of his meteorological observations for the month. In a report made to the British Association in 1863, he stated that the amount of this tide was about an inch and an eighth, and that subsequently a self-registering tide-gauge, similar to that used by Professor A. D. Bache on the Coast Survey, was put in operation at the port, the indications of which, deducing the curves from 5,450 half-hourly ordinates, between July, 1859, and November, 1860, gave results almost exactly corresponding with those of his original observation.

Mr. Lapham was engaged, almost from the beginning of his residence in Wisconsin, in the study of the aboriginal earth-works of the State. He was the first to notice that many of the mounds were really gigantic figures of men, beasts, birds, and reptiles; and as early as 1836 he gave accounts in the newspapers of a turtle-shaped mound at Waukesha and of several other effigies of animals. Perceiving the danger of these structures being obliterated, he, availing himself of assistance offered by the American Antiquarian Society, made a systematic survey of many of them, the results of which were published in 1855, under the title of "Antiquities of Wisconsin," in a fine, richly illustrated volume by the Smithsonian Institution. Twenty years later, near the end of his life, he prepared a series of bas-relief models of some of the more characteristic mounds, for the Centennial Exhibition of 1876.

In 1868 fragments of a meteorite, afterward known as the "Doerflinger meteorite," were found on a farm about thirty miles northwest of Milwaukee. A specimen of the stone was obtained for the Wisconsin Natural History Society, of which that body, in consideration of the services he had performed for it, gave a piece to Dr. Lapham. Examining his piece, which had been polished and etched by Dr. J. Lawrence Smith, of Louisville, Kentucky, he discovered in it the familiar crystalline markings known as the Widmannstättian figures, and within these another set of lines, to which Dr. Smith, on their being brought to his notice, gave the name of the Laphamite Markings. A representation of this stone, showing both sets of marks, is given in the new "American Cyclopædia," article "Aërolites." In connection with these observations, Dr. Lapham prepared a complete list of North American meteorites, with a map showing the exact place where every one fell, which, however, has not been published.

Dr. Lapham was one of the first men in the United States, if not the first, to move effectively in favor of general systematic weather observations for the purpose of forecasting and preparing for coming storms. Espy had shown that such a thing was possible; Professor Henry had

suggested, in 1847, that the telegraph might be used in aid of such a work; and the Cincinnati Observatory had issued a daily weather bulletin and chart in 1868 and 1869; but Dr. Lapham's efforts were the ones that bore fruit in the shape of national action on a national scale. In 1842 he published, for information and as a stimulus to harbor improvement, a list of marine disasters on Lake Michigan; in 1858 he suggested to a railroad manager, who was building a line of steamers for a lake-ferry, the importance of procuring a knowledge of coming storms. The manager answered, politely, that he had more confidence in the size and speed of his boats than in storm-signals. He afterward addressed a lake-captain on the subject, and the sailor replied that he had "little time to investigate meteorological papers, and had never been impressed with the opinion that our changeable and fickle climate could be put under any rules by which mariners might be guided with any certainty or much profit." The idea, however, was gradually commending itself to the moneyed men of Chicago, when, in 1869, Dr. Lapham met the Hon. E. D. Holton, who was just about to go to attend the meeting of the National Board of Trade, at Richmond, Virginia, and explained his scheme to him. Mr. Holton secured the passage, by the National Board of Trade, of a resolution which Dr. Lapham had drawn up, commending the project to the consideration of the Government. A bill, introduced by General Paine, of Wisconsin, for the establishment of the Weather Service, was passed, and on the 15th of March, 1869, "Old Probabilities," as the office was for a long time nicknamed, was installed. Dr. Lapham was appointed in November, 1871, Assistant Signal-Officer at Chicago, and had the pleasure of sending home, at the end of a month, a draft for "the first considerable sum I have ever received as salary for any scientific work." The amount was $166.67.

In 1873 Dr. Lapham was appointed, in accordance with an act constituting the Geological Survey of Wisconsin, Chief Geologist, with authority to select his subordinates. The fitness of the appointment was universally recognized, but by some oversight the nomination was not sent to the Senate for confirmation. The work was prosecuted by him with great energy and most fruitful results for nearly two years, by which time "the political aspect of the State had changed, and there had been an upheaval of strata of which our geologist had taken no notice." He first learned through the newspapers that he had been superseded. Nearly a month later (March 21, 1875) he received a letter from W. R. Taylor, Governor, notifying him that "all authority (if any possessed by you), as Chief Geologist, ceased and was annulled on the 16th day of February" previous.

On the 14th of September, of the same year, Dr. Lapham, having retired to his farm on Lake Oconomowoc, had just finished a paper on the capacity for fish production of that and other small lakes of Wisconsin. Then he went in his boat upon the lake. He was found a few

hours afterward, lying in the bottom of the boat, dead from heart-disease.

The nature and variety of Dr. Lapham's scientific pursuits are illustrated by his biographer, Mr. S. S. Sherman, in an anecdote: "When asked, by a gentleman well known in scientific circles, in what department of science he was laboring, he replied, 'I am studying Wisconsin.'" The variety and accuracy of his knowledge made him a kind of encyclopædia—a ready reference on almost every subject; and Mr. Sherman fills several pages of his biography with a list of questions on which he was consulted by farmers, citizens, miners, archæologists, amateurs, or scientific men like Professor Agassiz (to whom, apologizing at one time for not being able to send a better supply of certain fishes he had asked for, he pleaded that he was "not an expert fisherman"), Asa Gray, and Alfonso Wood. Professor Wood placed him "among the five or six most active and intelligent botanists in the country." Professor Gray declared him the pioneer botanist of his State, whose name would be inseparably connected with its flora, and called a new genus of plants after him, *Laphamia*. He was one of the founders of the Wisconsin Academy of Sciences, Letters, and Arts, an LL. D. (1860) of Amherst College, an honorary member of the Royal Society of Antiquaries of Copenhagen, and a member of most scientific associations of the United States. The list of his publications, some of the more important of which have already been indicated in the course of this article, numbers about forty-five titles. Ten of them are upon geological subjects, nine on subjects of botany and natural history, seven climatological and meteorological, three on the antiquities and the Indians of Wisconsin, three upon physical phenomena (the effects of the destruction of the forests, the great fires of 1871, and the great fresh-water lakes), and one is the article "Wisconsin" in the "American Cyclopædia." The others are topographical, or relate to miscellaneous subjects. The last was "The Laws of Embryonic Development the same in Plants as in Animals," which was published in the "American Naturalist" of May, 1875. Besides these, he left a mass of valuable notes and manuscripts, showing the fruits of industrious research.

# CORRESPONDENCE.

## THE AFRICAN IN THE UNITED STATES.

*Messrs. Editors.*

HAVING read with much interest Professor Gilliam's article on "The African in the United States," and agreeing with his general conclusion that "they must forever remain an alien race among us," it seems to me that there still remains something to be said, and that now is the time to say it, and this must be my excuse for this appeal to your courtesy.

The obstructive Chinese legislation was received at first, by most thinking men in the country, not in direct contact with the question, with aversion, and a regret at a departure from one of the first principles of our Government, viz., the equality of man. But most of us are now satisfied that while this American life is a furnace which melts into good Americans the peculiarities of all white races, the attempt to assimilate a race of different color, and of a civilization older than ours, and one that has resisted conquest, oppression, and time, would certainly have resulted in failure, and that a majority of citizens of Chinese birth or descent, on the Pacific slope, would have made of that section practically a foreign land.

That the case of the negro, as stated by Professor Gilliam, is hardly as bad, is evident. The negro is not the heir of an ancient and scientific social order. What knowledge he has of social order and political forms is American, and, however much he may develop, his development will still follow these lines, and there will hardly be a race war of virulence enough to attract the attention of the country as a whole. At the same time it is very certain that the fact of color will forever keep the two races separate, and that as the negroes realize the voting strength of mere numbers there will be a tendency among them to gather in certain sections of the country in overwhelming power, and by the perfectly legal means of the jury system and the ballot drive the whites, not only from office, but from among them. The process will be slow and gradual, and there will be probably neither occasion nor opportunity for the interference of the Federal power. But the concentration of an alien and unassimilable race in any section of the country, especially in a section of so much strategic importance as the mouth of the great river that is the future door to our house—however much their civilization may be an outgrowth of our own—is certainly a political arrangement to be avoided if possible. And how is it to be avoided? Professor Gilliam gives us no hint except the vague regret that the San Domingo purchase was lost to us. The history of the centuries is before us. The long education of the African is complete. The dark continent is opened. The slave has received his freedom. The generation that intervened between the slave and the conquering freeman of old has nearly passed with our bondmen of to-day. All things indicate that the time has come when steps must be taken toward the solution of the problem of the colored race among us, or we must pay in the future, as in the past, for our neglect or mistakes in dealing with this matter, with losses and suffering, perhaps again with blood.

A bill passing Congress establishing a steam mail line to Liberia from some Southern port—Charleston, or preferably New Orleans—with a subsidy for mail-carriage, sufficient to insure its being kept up, however great the expense, would have reasons in its favor worthy of the following considerations:

Our merchant marine is destroyed, and must for national and economic reasons be rebuilt, and, in spite of our present prejudice against subsidies, capital must at first be attracted to this field by national bounties. This is the way England's supremacy was organized, and is kept up. It is the way France and Germany are increasing their fleets, and there is no other way. Trade and travel follow regular steamship lines. This needs no demonstration. England's successful efforts in this direction keeps her to-day the workshop of the world. The wealth of Africa is at this moment the cynosure of industrial nations. England, France, and Belgium, by arts of peace or war, are pressing forward to take possession of its coast. It is only a question of time before, on some petty pretext, Liberia will be attacked and pass into England's possession, unless we cultivate closer relations. It is a country capable of great development. It is already progressing, and its governmental forms and traditions are American. The establishment of a steamship line to Liberia would produce the following results: The formation of a stable government in Africa, sprung from and modeled after our own. A nation that would assimilate and develop the native tribes instead of destroying them; a nation that would have our customs, our energy, and our tools, know and buy our wares, would, by the railroad-building arts they take from us, conquer and control the

heart of Africa, and, above and beyond the trade considerations, would settle forever, in accordance with natural development, the question of race hatreds among us, by affording a career in a new and virgin field, to every turbulent, reckless, and energetic spirit among the colored Americans. These are the advantages. The cost is the direct mileage to steamers of one thousand tons or upward capacity, less the indirect advantage of trade. The profit of the freight and passenger traffic is probable during the second year. The time is now. But the fact remains that the Solons at Washington are more interested in the distribution of the offices than the future prosperity of the country, and that our republic is so strong that no safety-valve is needed until after the explosion. C. E. CHITTENDEN.

SCRANTON, PA., *February* 15, 1883.

---

## RAILWAY CONSOLIDATION.

*Messrs. Editors.*

I ALWAYS enjoy and value your able journal, and feel in reading it that the actual facts are treated of without any fear or turning aside.

I must express particularly the degree of education I have received from the paper on railway consolidation as especially exemplified by the Union and Central Pacific roads.

I see now, what I had failed before to recognize, that only complete consolidation of all the routes to the Pacific is needed to perfect the contribution of all the railways can offer to rendering that coast Utopian in fact.

There were once impressions in the minds of ill-informed men that two gigantic and immensely subsidized corporations, the Pacific roads and Pacific Mail, had combined to wring all that was possible from the public that contributed so generously to give them existence.

Another fancy was, that rates were so much higher to points far this side of San Francisco, that shippers sent goods through and brought them back, at way-freight rates, to save money. It was even asserted that paying through rates would not secure the right of unloading *en route*.

Newspapers not inspired with integrity have even started the rumor that merchants who would not sign a bond committing themselves to sending all their freight by the Pacific roads were not given favorable rates. How sad that such things have been written and said; and how bitterly must men feel who read the last sentence of your exhaustive article, and are conscious that, before reading the decimals that so accurately measure the blessings of consolidation, they thought that roads untrammeled by legislation might become imbued with some selfish motive!

The odious term "monopoly" being treated with scientific accuracy becomes a charming expression, and, beyond question, the time will soon come when its perfection may be arrived at by the simple result of all transportation being consolidated in the hands of one man. Then it can be done at a minimum profit, from the fact that there will be but one family to maintain from the net earnings, and, of course, a railway-man is prone to all economy.

Very few feel called upon to pay their own fare, or the hauling of the cars in which they deny themselves the simple necessaries of life, sturdily confining themselves to the bare luxuries.

The tramps which the engines so often cast aside, mangled masses of flesh and old clothing, may have done more for practical progress than the railway "beat" who lords it at the stockholders' cost. But this is no matter, if the magnate who hurls along over unguarded crossings, with no regard for life or limb, can only go sixty miles an hour, and arrange a consolidation in a few moments.

It is well that your magazine can so readily dispel "fundamental misconception" by the clear enunciation of "economic laws" as to remove all the old ideas, in twelve pages of comparative lines and decisive decimals.

So guarded, the public is safe, and the "politician and the press," other than the strictly scientific, are needless.

Grateful for information so serene and simple, I am, yours very truly,

L. W. LEDYARD.

FERNWOOD FARM, CAZENOVIA, N. Y., *February* 19, 1883.

---

## THE COPYRIGHT DISCUSSION.

*Messrs. Editors:*

MY object in writing the article which appeared in your March number, on "Piratical Publishers," was to provoke such a discussion of the subject of international copyright as its importance demands, and I am neither disappointed nor displeased with the rather severe editorial strictures which followed it. But, while I am quite willing to concede that some of your arguments have sufficient force to weaken, in a measure, those presented by me, I am firm in the conviction that most of my positions have been unsuccessfully assailed.

I write, however, now, to prevent misapprehension, by stating—what I ought to have said before putting my name to the article referred to—that I have no personal concern in the question under discussion, being no longer a republisher, and having no interest, pecuniary or otherwise, in the

publishing business. Also that I have—or, rather, the publishing house which has so long borne my name has—for more than thirty years past, paid a liberal sum to all the English publishers whose works it reprinted, and that the most cordial relations between the parties have always been maintained; so that my article was not written in vindication of my own conduct, but, as already stated, for the purpose of presenting such extreme views on one side of the question as should call forth the strongest points that could be presented on the other, and thus bring about the fullest possible discussion on the subject. I trust your criticism is an earnest of what is yet to follow from those who may have access to the pages of "The Popular Science Monthly."

LEONARD SCOTT.

---

# EDITOR'S TABLE.

### *THE NEW SCIENTIFIC WEEKLY.*

SINCE our last issue the new weekly, "Science," an American journal, much on the plan of "Nature," has made its appearance at Cambridge. We had been much interested in the previous announcements of the project. The cultivators of science in this country are certainly sufficiently numerous to maintain an organ by which they can promptly communicate with each other and with the world on those multifarious results of investigation for which there have hitherto been but very inadequate means. The want of such a periodical has been long and urgently felt, and attempts have before been made to meet it, though not with success. Two things are required to put such an enterprise upon a satisfactory basis—the general and hearty support of scientific men, and capital enough for all the preliminary needs of the undertaking. "Science" has secured both. That it has the abundant confidence and cooperation of American scientific men in all departments of inquiry is attested by the large number of eminent names that have appeared in the newspapers in connection with it, and also by the statement of the prospectus that "'Science' has secured in advance the good-will and active support of a large body of the most competent scientific men of the country, as will sufficiently appear upon publication of a few numbers."

Equally necessary was a liberal provision of funds to float the enterprise. Notwithstanding the alleged interest in science with which our age is so abundantly credited, it remains doubtful if a journal designed mainly for the wants of specialists can be remunerating, at least until after a considerable period of time. It must chiefly appeal to the intellectual requirements of advanced men; but these form a large clientage. Working upon the frontiers of scientific thought, it will be conversant with inquiries that are, to a considerable extent, beyond popular reach. Records of the progress of research and criticisms of original work must inevitably be technical, and therefore but little attractive to the non-scientific classes. "Science" will, of course, have its popular features, but, if it does tolerable justice to the body of American investigators and gives us a weekly conspectus of the condensed results of current research in the scientific world, it can devote but limited attention to popular science. But, with abundant capital, it is independent.

The numbers of "Science" that have thus far appeared fulfill every reasonable expectation, and give assurance that the journal will take a high rank among periodicals of its class. There is, of course, room for criticism,

"SCIENCE": Published weekly at Cambridge, Mass. Moses King, Publisher. Proprietor, "The Science Company": President, Daniel C. Gilman; Vice-President, Alexander Graham Bell; Directors, D. C. Gilman, A. G. Bell, G. G. Hubbard, O. C. Marsh; Treasurer, Samuel H. Scudder, of Cambridge. Pp. 28. Published every Friday; price 15 cents per number, or $5 a year.

as there would be at any rate, whatever the excellence of its plan or the thoroughness of its execution; but its sagacious editors and enterprising managers may be best trusted to detect its deficiencies, and to repair them by self-correcting experience. The first number, of course, exemplifies the plan of the weekly. Besides its prospectus, and the opening introductory article, there are interesting communications from Professor Langley, Samuel Kneeland, Captain Dutton, and E. H. Hall, together with an admirable notice, by Professor Asa Gray, of Alphonse de Candolle's work on "The Origin of Cultivated Plants," contributed to the "International Scientific Series," and soon to appear in English. After a brief review of the "Natural History of Minnesota," we come to perhaps the most distinctive feature of the journal, in the "Weekly Summary of the Progress of Science" which is given in the first number, under the successive headings of Mathematics, Physics, Chemistry, Metallurgy, Geology, Meteorology, Physical Geography, Geography, Botany, Zoölogy, Vertebrates, Physiological Psychology, and Early Institutions. Several of these have subdivisions, as Acoustics, Optics, Photometry, and Photography, under Physics; and Fish, Reptiles, Birds, and Mammals, under the title of Vertebrates. The information is of the most varied kind, but all refers to recent observations, experiments, or inquiries. Each distinct statement or item is numbered, for convenience of future reference; and, in the ten pages here devoted to the weekly progress of science, we have seventy-nine of these brief articles, each signed with the initials of a responsible editor in his own branch. We know something of the immense care and labor which such a department involves. Following this is "Intelligence from American Scientific Stations," with "Notes and News," general and personal, and a copious list of "Recent Books and Pamphlets on Scientific Subjects." Our new journal is thus packed with the concentrated nutriment of science, and will have value wherever the substantial data of inquiry are appreciated. "Science" is sure to contain a great deal of information that is of general importance, and we cordially recommend it to the patronage of all classes who care anything for the positive advance of knowledge in this country.

It is proper to add that we are ourselves interested in the success of "Science," with special reference to our own line of work. The law of progress is ever through division of labor, which in this field takes the shape of specialty of publication. We have felt the need of such a periodical as "Science," because we have been pressed to do the work which it now undertakes, but which it has been impossible for us to perform. A monthly can never compete with a weekly or with the daily press in giving scientific news; as to do that work well requires a definite and comprehensive organization for the purpose, and a frequency of publication that shall secure the prompt diffusion of scientific intelligence. "Science" will do this work effectually, and, by becoming an organ of accredited discovery and authorized opinion, will leave us free to devote ourselves to popularizing and diffusing the approved results of scientific inquiry.

---

### *INCENTIVES TO THE PURSUIT OF SCIENCE.*

But while welcoming our new coadjutor with unqualified approbation as to its purpose and method, we confess to some misgiving about its first formal utterance on "The Future of American Science," which it is declared almost in a tone of jubilation is to be distinctively and supereminently utilitarian. The utilitarian passion of the American people, it is here maintained, must also become the animating impulse of American science. Criticism may seem un-

gracious in this place, yet we can not refrain from asking if it is quite appropriate to the character of such an enterprise to begin by letting down instead of elevating the ideal of inspiration in the pursuit of original science.

After commending the men of the past who have made eminent achievements in pure science in this country, the writer says: "The leading feature of American science, however, and that which most distinctly characterizes it, is its utilitarianism. True there are in our country able investigators working in scientific fields which do not offer the promise of material reward; but, notwithstanding this, it remains still true that those sciences whose principles are capable of useful application are the most zealously cultivated among us, and attract the largest number of students. Nor is this to be at all regretted. Research is none the less genuine, investigation none the less worthy, because the truth it discovers is utilizable for the benefit of mankind. Granting even that the discovery of truth for its own sake is a nobler pursuit, because a less purely selfish one, does it become any the less noble when it is ascertained that the truth thus discovered is capable of important applications which increase tenfold the happiness of human life? It may readily be conceded that the man who discovers nothing himself, but only applies to useful purposes the principles which others have discovered, stands upon a lower plane than the investigator. But when the investigator becomes himself the utilizer, when the same mind that made the discovery contrives also the machine by which it is applied to useful purposes, the combined achievement must be ranked as superior to either of its separate results."

There is here a reversal of the gradation in the motives to scientific study which has been too long and too clearly recognized to be lightly brushed aside. The most exalted incentive in the pursuit of truth is that high appreciation of it which makes its bare discovery the supreme compensation of the investigator. There is deeply implanted in the human mind a desire to find out the secrets of nature; and there is a pleasure in the satisfaction of this desire which has ever been the sharpest spur of scientific research. It is, moreover, this impulse to seek the truth of nature for the simple love of it that has played much the most prominent part in the progress of science. But, though animated by a noble purpose men are human still, and so they have been also impelled to scientific discoveries by the lower impulses of personal ambition, or because of the honor and fame they will confer. There is, besides, an inducement to scientific inquiry on account of the usefulness of its results in practical life, or the motive of public utility. And, finally, there is the desire to reach new results for the selfish individual advantage of turning them to profitable account: this is the mercenary motive, and is, of course, the lowest of all.

Now, human motives are often a good deal mixed, yet dominant intentions are not difficult to detect. In this case, what a man does with his discovery must be taken as proof of his intention in making it. If a man finds out a new fact, makes a new observation, or works out a new principle, and then communicates it to the world, he is to be fairly credited with the motive of laboring for the increase of knowledge for the sake of knowledge. If he is solicitous about the priority of his result, we know that he prizes the personal honor that it will confer. If he makes a discovery and applies it to some useful end, and then presents it to society for the promotion of the public good, he is to be credited with the philanthropic motive of contributing to the common utility. But, if he makes a discovery, and, shrewdly keep-

ing it to himself, applies it to a practical use, and then patents it for his own profit, the act qualifies the motive as selfish and sordid, and of the lowest kind. The writer in "Science" maintains that where an invention is tacked on to a discovery, the compound result must be superior to its separate elements. But invention is not science, and can not count in ranking scientific achievement. Rank is here determined solely by the elevation or the degradation of the motives by which men are impelled to research. Davy made discoveries in combustion which enabled him to invent the safety-lamp, but he at once gave it freely to the world. Dr. Wollaston discovered the malleability of platinum, and devised the means of producing it on a commercial scale, but he kept his inventions a secret and acquired great wealth by them. The two transactions, however, are ranked in scientific history as of two orders, and as widely apart as generosity is from greed.

Inventions are excellent things, and we have certainly no objection to patenting them; but, as we have said before, they are not parts of science, and when introduced in connection with the work of scientific discovery they serve only to mark the lower purpose for which it is pursued. We are not responsible for this mixing up of patent-rights with science, and protest against the use of them to magnify utility, and cast virtual disparagement upon the highest motives of scientific investigation. The writer upon "The Future of American Science" identifies the interests of invention with those of science in a way that antiquates the simple-minded devotee to truth for its own sake. He says: "The inventive genius of this country is pre-eminent. We reap the benefits of it on every side. Our houses are more comfortable, our railways more safe, our fabrics cheaper, and our education more thorough, because of useful inventions. Becoming restive at the slow progress of discovery, the inventor has himself assumed the *rôle* of investigator; and the results of his researches appear in the records of the Patent-Office. In the olden times, the investigator was content to make his discoveries, and to publish them, consecrating to science the knowledge thus obtained. His more modern representative carefully treasures what he has discovered until he has exhausted its practical application. In consequence, the discoveries upon which many of the most important scientific inventions of the day rest will be searched for in vain in scientific literature. The telegraph, the telephone, and the electric light are inventions which illustrate the fact now stated in an eminent degree."

The significance of the new departure, which substitutes the lowest for the highest inducement to scientific labor, is here sufficiently apparent. It is the old fogy of "the olden times" that was content "to make his discoveries, and to publish them"; it is his wide-awake "modern representative" that keeps his results to himself until he can turn them to the purposes of private speculation, through the agency of the Patent-Office. But if it is not to be the policy of the coming scientific utilitarian to publish, pray what is the function of the new weekly? And, when the inventor gets "restive at the slow progress of discovery," and proposes to take hold of it himself we may commend his enterprise, but there are some things of which it is desirable that he should be reminded. First of all, and as a matter of fact, scientific truth has been a slow growth of ages. "The telegraph, the telephone, and the electric light" illustrate a good deal more than is here stated. Centuries of labor, and the blood of generations of indefatigable scientific workers, had been expended in experimental researches upon electricity, before the facts were disclosed and the principles

established which have now become available in their useful applications. Priestley's "History of Electricity," published a hundred and sixteen years ago, was even then a ponderous volume, though it was but an epitome of older successful work, and took little note of the labors that failed to issue in new results. Science is, indeed, a *very* slow growth, and long periods of unremitting toil must pass before its final stages of flowering and fruiting are reached, even in those comparatively few cases where the fruit can be turned into gold. There are those who have at length the good fortune to shake the tree of scientific knowledge when its fruit is ripe, and they may be alert to clap the padlock of the Patent-Office on their results so as to be able to use them with profit; but there can be no greater mistake than to assume that the time has come when scientific workers generally can be encouraged to devote themselves to the reaping of the profitable pecuniary harvest of past researches. In the broad field of original scientific investigation, not one part in a hundred is capable of being cultivated with any possible hope of turning its results to pecuniary account. A hasty glance at the pages of "Science" is quite sufficient to show the utter futility of supposing that the multifarious labors there indicated can ever issue in any pecuniary advantage to those who perform them.

But the writer in "Science" pushes his case still further, as follows:

> The science of to-day is in thorough accord with the spirit of the American people. They are proud of every achievement it makes, and are satisfied with the returns it is giving them for their investments. To continue this *entente cordiale* should be the object of every scientific worker. He may the more readily concede some practical return for the facilities for investigation which the people have furnished, since the march of discovery is not in the least hindered but rather promoted by the practical application of the new truth it develops. His attitude toward invention should be appreciative and cordial. He should cast aside all prejudice against the man of patents and practical devices, and should stand ready to welcome the investigator, in whatever garb he appears.

Again we protest against this confounding of science with business. The writer talks about the American people investing in science, and being satisfied with the returns. But science is not a thing to be invested in; people invest in patent-rights and stock-companies, and may be well pleased with their returns, and proud of their inventors, but they are not therefore patrons of science. Let the man of patents stand upon his own merits, and go for what he is worth, and not construe the success of his business operations as an evidence of the high public appreciation of genuine scientific work.

The disparagement of scientific investigation from its highest motive, by the writer in "Science," is undisguisedly and almost offensively explicit. He says, "While the scientific cynic may condemn the utilitarianism of our age, the more liberal man rejoices in it." The devoted student, impelled by the loftiest spirit, which refuses to be influenced by lower considerations, is not well characterized as a "scientific cynic"; nor is he who works from the lowest motive entitled to applause as "the more liberal man." We reiterate that the nobler motive has been a thousand-fold more potent in creating the great body of scientific truth than the more sordid motive. The one supreme lesson taught by the history of science for the last three centuries is, that the world mainly owes its great results to the single-minded devotion of its cultivators, to the pursuit of truth for the sake of truth alone. This has ever been, and it must always continue to be, the most elevated and generous, as well as the most powerful mental motor in the prosecution of truly scientific investigations. That there is a wide-spread and an active tendency in this country to degrade science to the low, money-making

level of a society immersed in material interests and given over to the pursuit of wealth, is no doubt true, but it is a state of things to be deplored and to be withstood, rather than to be complacently accepted and applauded. Let men pursue science from whatever motive they will—all valid results are valuable—we only object to this formal surrender of the highest ground at a time and in circumstances which require that it should be steadfastly maintained. It is neither possible nor desirable to disconnect science from its useful applications, but as Goethe says, "the useful may be left to take care of itself"; there is no danger of its being neglected. Our objection is to this inaugurating something like a national policy of science, animated by the mercenary spirit which it has been the glory of science to have always resisted as the proper or highest motive of its cultivation.

---

### *HINDRANCES TO THE SCIENCE OF POLITICS.*

We briefly notice, in its appropriate place, a new book having the title of the "Science of Politics," and we reprint a portion of its important preliminary chapter, designed to point out the nature and limits of this alleged science. The author shows the valid grounds upon which it rests, and the certainty of its future development; but he at the same time indicates very clearly the formidable difficulties which hinder, and will long continue to hinder, the recognition of politics as a regular branch of scientific inquiry.

And among these obstacles attention is called to one which seems singularly enough to be itself a product of political progress: it is that a conception of a scientific politics may be expected to meet with most resistance under governments theoretically most liberal and advanced. We should certainly anticipate that where there is the greatest intelligence, and the form of government is most popular, there would be the greatest tendency to the study of political institutions from a scientific point of view; and accordingly we might expect that the subject would be congenial to American students of political affairs. And yet it is probable that nowhere else will there be found so wide-spread and pronounced a skepticism in regard to it as in this country. If we could take the sense of the American Congress upon this point, who can doubt that its members would decide with the greatest unanimity that there is, and can be, no such science as that of which our author undertakes to lay down the elements? Nor can we for a moment expect that the law-makers in all our State Legislatures would disagree with such a congressional decision. So much, at any rate, may be assumed, that, whether or not there be such a thing as a possible or actual science of this kind, American politicians generally are profoundly ignorant of it, and will, moreover, have little interest to inquire seriously into its claims. Nor can we escape the conclusion that, of all classes of the community, none are so little concerned about politics, as a problem of principles, as the class of men who make politics a profession. This is a curious state of things in a country where we hear on every hand that intelligence is the first condition of the perpetuity of popular government. While intelligence is held to be so fundamental a necessity in this republic that the state actually assumes the duty and the responsibility of molding the minds and characters of its citizens into conformity with our political requirements, yet the idea that there is any science or fixed order of relations, or inevitable working of cause and effect, in the political sphere, will be generally scouted as chimerical.

What is the explanation of this anomalous state of things? The answer is, that the most popular forms of government engender the worst forms of poli-

tics, and favor and foster states of mind that exclude all considerations of a scientific nature. This may be an unpalatable conclusion, but unpalatable conclusions are often true. We have to face the disagreeable fact that it is under the most liberal and perfected political institutions, so called, that the incalculable element of personal caprice in political affairs comes into greatest ascendency. We speak of kingly rule as the type of personal government, but personal government is only seen in its highest power and effect where each citizen has become a sovereign. It is only where the self-seeking of the single monarch is multiplied by millions in a nation of potential office-holders, that the selfishness of personal politics rises to its maximum influence. It is only in a country where everybody is eligible to office, where the incentives to office-seeking are universal, where politics has become such a national passion that the whole scheme of public education is subordinated to it, that personal aspirations and the interests of selfish ambition will dominate unrestricted in the management of public affairs. And it is undeniable that politics with us is coming to be more and more a business, a vocation to be pursued for profit and emolument by successful office-seeking. Under such a system the winning politician will not be the man of intelligence, deliberation, and principle, but the man skilled in all the low arts which will insure political success. He will be the shrewdest operator of the partisan mob. Nothing is more notorious than that under the working of our popular political institutions, the best men go to the wall, and the worst men come to the front. By the very conditions of the case, it is the crafty operators, the long-headed managers, caucus manipulators, party intriguers, and brazen, indefatigable demagogues, who secure the offices. From the General Government down through all the ramifications of legislation and administration to the petty town officials, the places are filled by partisan professionals, so that the first presumption in regard to an office-holder is that he is unfit for the place. And such is the extent of this field, and the intensity of the competition in it, that the preparation for it is of the most absorbing nature, so as to afford a virtual guarantee that the incumbents of office will be profoundly ignorant of all that it is most important for them to know. These are of course not the men to appreciate the scientific elements and aspects of governmental affairs. Such considerations are not available for their purposes. Everything like statesmanship, the forecast of distant consequences in government policy, will be excluded from their minds by the pressure of immediate interests, the advancement of personal projects, and the achievement of political success in accordance with current ideas. The politician looks out first for himself, and all his study is to get a better thing than he already has. Only the one at the top can get no higher, and his soul is devoured by the ambition to be re-elected By the very instinct of the situation, which involves calculations of immediate effect, the politician will be comparatively indifferent to all those slow-working agencies which yield enduring results of the highest value, and which it is the great object of science to elucidate, and of genuine statesmanship to recognize in government policy.

In dealing with the hindrances to the due consideration of a science of politics, the author of the work referred to remarks as follows upon the adverse tendencies which are to be met with even under the best governments:

> The topic is naturally relegated to the region of caprice and accident, or to that of tentative experiment and spasmodic contrivance. This intellectual consequence is intensified by the fact that all governments—and not least those known at the present day as the freest, and, on the whole, the sound-

est—are habitually made the arena of purely ambitious contention, of selfish aspiration, and even of corrupt conspiracies against the public well-being. The wider the territorial area of any particular government, and the more complicated and extensive its essential mechanism, the more opportunity is there for the exhibition of personal, or, at the most, of local self-seeking. So far as this prevails, politics becomes degraded into a mere vulgar struggle for money, office, or power. All actual reference to scientific considerations is excluded. The tone of public thought and sentiment becomes proportionately infected, and all the claims which might otherwise be asserted on behalf of politics to take its place by the side of other sciences dealing with such moral elements as the human will meet with a skeptical repudiation.

## LITERARY NOTICES.

INTERNATIONAL SCIENTIFIC SERIES. No. XLIII.

THE SCIENCE OF POLITICS. By SHELDON AMOS, M. A., author of "The Science of Law," etc., late Professor of Jurisprudence in University College, London. Pp. 490. Price, $1.75.

IT is doubtful if any book could be offered to the American public of which they would be so little able to judge what it might be about, as a treatise on "the science of politics." It would rather be expected that the writer would choose some such title to give respectability and character to new political theories of his own, and it would at any rate be anticipated that the work would be largely of a visionary and speculative nature. Yet no such expectation would have been justified in the present instance. Professor Amos has given to the world an instructive and valuable contribution to the important subject which he has felt it incumbent upon him to undertake. It is first of all a moderate, judicious treatise, indulging in no extreme or extravagant views, and imbued throughout with the true scientific spirit. Professor Amos has this claim, which is probably an advantage in the treatment of his subject: he is not a man trained in the field of physical science who has felt that he had a mission to carry physical methods of study over into the political region to open a new dispensation of political philosophy. On the contrary, he is an erudite student of history, law, and civil institutions, and has made jurisprudence and the working of political constitutions a matter of life-long and critical investigation. His preparation has been in the general field which furnishes the subject-matter of his book, and he has come to the large conception of a science of politics through inquiry into the relations of political phenomena. From this consideration, his work will have a weight and a practical character which no amount of preparation in the special sciences could have given it. We are of opinion that Mr. Spencer's "Development of Political Institutions," dealing strictly with the subject from the point of view of historic evolution, is probably a more valuable contribution toward the organization of a political science than this work of Professor Amos, and yet it may not be so well adapted to interest general readers in the claims and grounds of this new subject. At all events, Professor Amos's book is better suited to the state of mind of politicians, who, being generally of the class of lawyers, will be more familiar with his data and the questions he discusses than they would be with the rigorous inquiries into the genesis of political ideas worked out by an analysis of primitive society. The plan of the work before us may be best gathered from a statement of the topics dealt with in its successive chapters. These are: I. "Nature and Limits of the Science of Politics." II. "Political Terms." III. "Political Reasoning." IV. "The Geographical Area of Modern Politics." V. "The Primary Elements of Political Life and Action." VI. "Constitutions." VII. "Local Government." VIII. "The Government of Dependencies." IX. "Foreign Relations." X. "The Province of Government." XI. "Revolutions in States." XII. "Right and Wrong in Politics."

Obviously the first implication of science is of laws or principles of a general nature, or that are universal in their operation. A science of politics, therefore, if there be such a thing, must deal with political phenomena in their most comprehensive forms, or as exemplified under wide diversities of constitution. It will be seen from the titles above enumerated that the range of discussion in the present volume is broad, and deals with all the chief fundamental problems relating

to the policy of government. Under the forms of diverse institutions, Professor Amos seeks to trace the tendencies and influences that are at work for good or for evil, and by which the value of the accompanying forms must be judged. The book, in the nature of things, can not be as spicy as a treatise on local politics, appealing to the bias and prejudice of patriotic feeling, but just for this reason its influence will be salutary and wholesome. We greatly need that catholicity of view in dealing with political subjects which it is the object of science to illustrate and enforce.

DESCRIPTION OF HOUGHTON FARM by H. E. A.; with experiments on Indian Corn, 1880–'81, by MANLY MILES, Director of Experiments. With a Summary of the Experiments with Wheat for Forty Years at Rothamsted. Cambridge: Printed at the Riverside Press. Pp. 75.

EXPERIMENTAL scientific agriculture — anything truly entitled to the name—is perhaps one of the most difficult things that a man can undertake. Experimental science, anyhow earnestly pursued, is the hardest kind of work. Mere experiments are, of course, easy enough, and it is easy to parade their results and talk about new discoveries, of which people generally know nothing. But to make experimental investigations tributary to any real advance of knowledge, to get new and valuable results which will stand, or to give greater precision and trustworthiness to accepted conclusions, is as far as possible from easy, and is, indeed, so difficult as to be but rarely attained. It is quite a mistake to suppose that laboratories grind out new truth with the regularity of a flouring-mill. Elaborate experiments may go on for years, and nothing come of them worth preserving. It is exactly this difficulty in getting it that makes scientific truth so precious. It is like diamond-digging, only the "finds" are much less frequent, and infinitely more valuable.

But, if in each of the sciences, with perfected equipments of research and a comparatively narrow field, it is so hard to add anything new to the stock of knowledge, how much more difficult must it be when the attack is made upon a whole group of mutually dependent sciences! The farm, taken as an arena of experiment, is itself a congeries of laboratories. The phenomena involved are physical, chemical, geological, meteorological, and broadly biological—that is, embracing the economy of vegetal and animal life, from mildews to fruit-orchards, from insects to vertebrates. To know the nature of the soil, the nature of the air, the nature of fertilizers, the nature of plants and animals of all kinds, so as to study them in their vital connections by experimental processes that shall bring out valuable and lasting results, is hence, as we have said, one of the most formidable of tasks.

In the first place, there will arise all the difficulties encountered in the pursuit of the special sciences, with the disadvantage that the means of investigation are very rarely so perfect. But the peculiar and most formidable difficulty of agricultural science arises from the fact that the farm is itself a grand laboratory of nature, which imposes its own conditions of inquiry. And the first of these conditions is, that Nature must be taken at her own pace. Her processes go on at their own rates, and can not be much forced. The natural changes involved in agricultural effects proceed slowly, and the experimenter must conform his plans to this fact. The changes of soil, the action of fertilizers, the improvement of crops, the culture of stock, involve slowly accumulating results, require time, and, in addition to knowledge and skill on the part of the investigator, he must also have patience and perseverance, remembering that the fruits of his efforts belong to the future. Agricultural science, if honest, can not strike for immediate results; that scientific farming which demands something to display promptly, like prize-cattle and prize-crops, or that seeks to astonish the neighborhood, is a sham, and only brings an excellent thing into unmerited disgrace. This is what must be, and what is shown by abundant experience. The farm establishments started by rich men for the promotion of agricultural science, and which have come to nothing, may be counted by hundreds. On the contrary, the one which has a world-wide reputation for having made the largest contribution to agricultural progress is working by a system which requires a long series of years to develop its results. The Rothamsted farm of Messrs.

Lawes and Gilbert has been forty years in getting under way, and its most important results are still matters of hope and belong to the future. This is in accordance with the spirit and requirements of true scientific agriculture.

We have been led to these remarks by an examination of the pamphlet before us, which reports the initial steps of a new American attempt at scientific agriculture. Six hundred acres of Orange County land, named Houghton Farm, and owned by a wealthy manufacturer, Mr. Lawson Valentine, have been devoted by him to "a long-cherished plan for doing something toward the progress of American agriculture." The proprietor resolved that to attain this object he would constitute "a scientific department devoted to agricultural investigation and experiment, and that such department be of the highest order"; and that "the farm operations be carried on in accordance with the best-known methods and under the best possible organization and management, with a view of educating and enlightening others by furnishing valuable examples and results in practical agriculture." A good deal of hard thinking and difficult work was here laid out for somebody, and very naturally Mr. Valentine, a business man, cast about for able help in carrying on his enterprise. He had the good fortune to secure the services of Dr. Manly Miles, of the Michigan Agricultural College, a man well prepared for original agricultural investigations, to take the direction of the farm experiments. It was proposed to attempt for Indian corn in this country what had been done for wheat by Lawes and Gilbert in England—that is, to carry its cultivation through a course of years on assigned plots of ground, for the purpose of determining the quality and quantity of the product with different fertilizers, different modes of treatment, etc. The pamphlet before us contains Dr. Miles's report on the work of 1880–'81. This report lays down the method to be pursued, and embodies the first results. It indicates the plans of drainage adopted, gives the previous history of the plots of ground, describes the selection of seed, and gives the carefully tabulated results from unmanured plots, plots treated with farm-yard manure, and a considerable number of the most important artificial fertilizers. The mechanical operations of culture are carefully described, the peculiarities of the season recorded, and there is a minute description of the precautions taken to determine accurately the quantitative results of the matured crops. The main results, of course, assume a tabular numerical form, but Dr. Miles has also introduced very successfully the graphic method of conveying generalizations and comparisons to the eye by means of diagrams. There are all the indications in this report of intelligent, conscientious, painstaking, and persevering work. The document is undoubtedly valuable for the positive information it contains, although from the nature of the case the first results of such a trial-series of experiments must have the lowest value of any terms of the series. Single experiments in agriculture are worth but little, and only become valuable as they are verified. Time and continued research are indispensable for the elimination of error.

No one can carefully examine this report without recognizing that the experiments were intelligently planned and thoroughly executed as far as they went, giving promise that by rigorously carrying out the system adopted still more valuable results will be attained. We have been informed that, when Dr. Miles undertook the work, he did so under the explicit condition that he should have charge of the experiments for at least a period of ten years, that time being indispensable to achieve anything worthy the name of a contribution to agricultural science. Yet, after a year of preparation, and two seasons of systematic work, presto, the director of experiments at Houghton Farm is found installed as professor in the Agricultural College at Amherst, Massachusetts. What there was about these initiative experiments on Indian corn which Mr. Valentine found unsatisfactory does not appear in the document before us; but we have heard that the director of experiments was complained of as "slow." This is probably because striking results did not come out fast enough to suit the enterprising proprietor; but, if so, it does not augur well for the usefulness of Houghton Farm. That highest order of

progressive agriculture which is really to educate a community is not accompanied by monthly displays of sky-rockets. A "fast" director of experiments may astonish the natives with his performances, but cautious deliberation is one of the first conditions of scientific success. Quickstep, hurrah-boys scientific agriculture, which demands that there must be something to show by a week from next Saturday that will make a rattle in the newspapers is quite too-too to be of much value to anybody. No doubt your enterprising American is not going to dawdle forever over miserable trifles, but for that simple reason not much is to be expected of him in the way of the substantial advancement of science.

ANATOMICAL TECHNOLOGY, AS APPLIED TO THE DOMESTIC CAT: An Introduction to Human, Veterinary, and Comparative Anatomy. With Illustrations. By BURT G. WILDER, B. S., M. D., and SIMON H. GAGE, B. S. New York and Chicago: A. S. Barnes & Co. Pp. 575. Price, $4.50.

THIS book is intended as a guide to students in their early dissection-work. The experience of the authors has led them to choose the cat for the subject to be treated, as being the mammal most nearly resembling the human species, which is readily obtainable, and of convenient size to dissect and preserve. They begin at the beginning, and give full directions in regard to weights and measures, terminology, note-taking, instruments and their care, killing the animal, etc., and throughout the book the methods of dissecting and preserving the several parts are fully detailed. The book does not aim to describe all the muscles, veins, nerves, etc., of the animal, and it gives a large proportion of space to the viscera. The illustrations are numerous, and where possible the technical names are printed upon the several parts. There are numerous lists and tables, and many references to other publications, which afford collateral reading. While this is a work adapted to a physiological laboratory, where, no doubt, it has been prepared, yet it will be of service to many who are denied the opportunities of such an institution. It will be a very useful book for young students at home, who propose to pursue the medical profession. Like all other manipulation, the earlier dissection is practiced the better, and certainly the earlier the student gets an outline knowledge of practical anatomy by his own examination of anatomical structures, the greater will be his advantage when he comes to the crowded and multifarious studies of the medical college.

EXPERIMENTAL PHYSIOLOGY, with an Address on Unveiling the Statue of William Harvey. By RICHARD OWEN, C. B., M. D., F. R. S., etc. London: Longmans, Green & Co. Pp. 216. Price, 5 shillings.

THE advancement of the healing art by means of experimental research is the subject of which this little volume treats, and which also forms the theme of the address that is prefixed to it. In England vivisection has been closely restricted by act of Parliament, and a society exists whose aim is to entirely suppress the practice. Dr. Owen demonstrates the unreasonableness of the supersensitive members of this society, by showing how immensely the physician's power of relieving human suffering has been extended by the knowledge gained by Harvey, the discoverer of the circulation of the blood, by Hunter, and by later experimenters, through vivisection. He mentions aneurismal and intra-abdominal tumors, fevers, and nervous diseases as among the disorders for which vivisection has suggested means of successful treatment. Among the lesser ills he mentions the pain in teeth that have been filled, and states that a method of devitalizing the tooth-pulp was discovered through experiments on three dogs. "As many millions of human beings have been and will be, in the present generation, relieved through Dr. Arkövy's vivisections from sufferings equal to, perhaps greater and much more prolonged than, those which were endured in behoof of those millions by three dogs. Add to these millions the generations of the so-relieved in time to come."

PHYSICS, AND OCCULT QUALITIES. By WILLIAM B. TAYLOR. Washington: Judd & Detweiler, Printers. Pp. 50.

THIS is the retiring president's address, delivered before the Philosophical Society of Washington on the 2d of December last.

Its subject is really an examination of the dynamic and kinematic theories of force, and its tendency is to disprove the sufficiency of the kinematic theory to explain the phenomena for which it endeavors to account. The conclusion, which is expressed with several variations of phrase, is reached, after a course of very close reasoning, that, "do what we will, we can not escape . . . the certainty of conviction that the ultimate must in the nature of things be forever the unintelligible, the inexplicable, the inscrutable; that (paradoxical as it may sound) no explanation can be accounted final until it has been pursued backward to the unexplainable."

BAROMETRIC HYPSOMETRY AND REDUCTION OF THE BAROMETER TO SEA-LEVEL. Washington: Government Printing-Office. Pp. 47.

THIS publication is part third under the head of "Methods and Results" of the Meteorological Researches of the United States Coast and Geodetic Survey. The first part explains the theory of barometric hypsometry employed in the survey, which is based on the improvement and correction of Laplace's formula for the determination of altitudes, with the inclusion of minute terms which had never been taken into account in former investigations; and the second chapter describes the practical applications of the theory. The whole is followed by a series of hypsometrical tables.

THE ELEVENTH COMMANDMENT: A ROMANCE. By ANTON GIULIO BARRILI. From the Italian by CLARA BELL. Revised and corrected in the United States. New York: William S. Gottsberger.

THE Convent of San Bruno, in the Apennines, is the scene of the chief events related in this romance. It was occupied by fourteen bachelors, who had become brethren through sorrow. They were mostly men of science, in the prime of life. There was a physician, an archæologist, a librarian, an historian, an astronomer, a chemist, and so on. The prior, an attractive gentleman, of about five-and-thirty, was something of a philosopher. He is described as "not more than half a solemn personage, and he wore his long, snuff-colored frock with a jaunty air and an easy grace." This new order of friars, without the religious purpose and devoted to study, formed a little world of its own, free from the worries of the great world that come to it through the affections and ambitions. To learn for what reasons, and in what way, a lovely young woman disguised herself and gained admittance to the brotherhood, and for an account of all the consequences that followed, the reader is referred to the translation, which was made expressly for the publisher.

SIGNAL-SERVICE TABLES OF RAIN-FALL AND TEMPERATURE COMPARED WITH CROP-PRODUCTION. By H. H. C. DUNWOODY, Acting Signal Officer. Washington: Office of the Chief Signal Officer. Pp. 15.

TABLES are given by months and by seasons for the years 1875 to 1882, inclusive, for ten distinct divisions of the United States, showing the excess or deficiency of rain-fall and in temperature; by years of the average yield per acre of the principal crops; and statements of the year of the largest yield of each of the crops, for the several divisions. The student is left to draw his own conclusions as to the connection between rain-fall and temperature and the yield of the crop. Only one conclusion is given. It is by Professor Davidson, of the Coast Survey in California, that each inch of rain-fall in San Francisco promised a yield of one million bushels of wheat in the State.

A STUDY, WITH CRITICAL AND EXPLANATORY NOTES, OF ALFRED TENNYSON'S POEM OF "THE PRINCESS." By S. E. DAWSON. Montreal: Dawson Brothers. Pp. 120.

THE substance of this essay was originally prepared as a paper to be read in a small social-literary society; and it is now published, with notes, as a sort of provocative, to induce the production of other monographs on Tennyson's works. A note on the lines—

"When the man wants weight, the woman takes it up,
And topples down the scales"—

furnishes a little information respecting the way that the females of certain species of birds are said to have of taking up masculine traits when their males lay them down.

TEXT-BOOK OF GEOLOGY. By ARCHIBALD GEIKIE, LL. D., F. R. S. With Illustrations. London: Macmillan & Co. 1882. Pp. 971. Price, $7.50.

THIS last and largest work of the distinguished Scotch professor will be a welcome addition to the small list of really valuable text-books on geology. Although on this side of the Atlantic it will not take the place of our American manual as a *text-book*, it will be widely read by those who, whether geologists or not, take an interest in the past history and present composition of our globe. The treatment is such as will interest the general reader, and enable him to acquire a good grasp of the general principles of the science without tiring him with detail. The author's article on "Geology" which appeared in the "Encyclopædia Britannica" in 1879 forms the basis which has since been expanded into the treatise before us.

The volume is divided into seven books, of unequal length, devoted respectively to "The Cosmical Aspects of Geology"; "The Materials of the Earth's Substance: Dynamical Geology"; "Structural Geology, or, the Architecture of the Earth's Crust"; "Paleontological Geology"; "Stratigraphical Geology"; and "Physiographical Geology." Under the first of these heads, which will be for the general reader the most interesting of all, the various theories that have been advanced to account for the alterations of climate and the occurrence at intervals of cold cycles are discussed. The chapter closes with an interesting abstract of Dr. James Croll's researches upon the physical causes on which climate depends. In the next chapter, that on geognosy, the probable condition of the interior of the earth is considered, the author favoring the view that "the substance of the earth's interior is probably at the melting-point proper for the pressure at each depth." The age of the earth and the measures of geological time are next discussed. This chapter contains a brief description of the rock-forming minerals, as also the macroscopic and microscopic characters of rocks, and a classification and description of the more important kinds of rocks, with the methods used in determining them.

The processes of change at present in progress upon the earth are very fully considered in the third chapter, that on dynamical geology, which covers nearly three hundred pages. This forms one of the most interesting and instructive features of the book, and will be widely read. The short chapter on paleontological geology is far from being dry or uninteresting, containing as it does a description of the conditions essential for the entombment of organic remains on land and sea, their preservation in mineral masses, the relative value of such remains, and their uses in geology. This is a most essential preliminary for a correct understanding of the following chapter, on stratification. Nearly one third of the volume is devoted to a description of the various strata, with illustrations of the principal fossils found in each, and concluding with the flint implements of the recent or human period.

Being designed as a text-book for use in Britain, local examples are chosen for illustration, but the author is fully alive to the fact that America furnishes many unequaled illustrations of some of the most important facts of geology. For his frontispiece he selects the plateau and cañons of the Colorado, the drawing being a reduction of one made by Mr. W. H. Holmes, and several cuts are introduced into the body of the work representing views in Colorado, Idaho, and Montana. In his preface he says: "Comparatively few of us have any adequate conception of the simplicity and grandeur of the examples by which the principles of the science have been enforced on the other side of the Atlantic." And further on he says: "If the student is led to study with interest the work of our brethren across the Atlantic, and to join in my hearty regard for it and for them, another important section of my task will have been fulfilled. And, if, in perusing these pages, he should find in them any stimulus to explore nature for himself, to wander with the enthusiasm of a true geologist over the length and breadth of his own country, and, where opportunity offers, to extend his experience and widen his sympathies by exploring the rocks of other lands, the remaining and chief part of my aim would be attained."

Geology is such a progressive science

that we are not surprised to find much new matter which has never before been fully presented in any systematic treatise, and, to those who wish to keep abreast with the times and with the latest views of geologists on all important questions, we can recommend a perusal of Professor Geikie's work, the value of which to the student is greatly enhanced by his copious references to authorities and works consulted.

ANNALS OF THE ASTRONOMICAL OBSERVATORY OF HARVARD COLLEGE. Volume XIII. Part I. Micrometric Measurements. Cambridge, Massachusetts: John Wilson & Son. Pp. 204.

THE work tabulated in this volume was done with the equatorial telescope of fifteen inches aperture, from 1866 to the close of 1881, under the direction of Professors Winlock and Pickering, the successive directors of the observatory, and includes observations of double stars, nebulæ, the satellites of Saturn, Uranus, Neptune, and Mars, the asteroids, comets, and occultations. Micrometric determinations of position, except in the cases of small stars near the equator and in and near the nebula of Orion, the results of which have appeared in former volumes, have formed only a small part of the work done with the large telescope; and the present volume records chiefly the miscellaneous micrometric work that has been accumulated during the intervals of other investigations.

QUINTUS CLAUDIUS: A ROMANCE OF IMPERIAL ROME. By ERNST ECKSTEIN. From the German by Clara Bell. New York: William S. Gottsberger. 2 vols., pp. 313, 303. Price, $1.75.

THIS is an attempt to reproduce in a life-like form, and with the interest of a romance, the manners and moods of a past age. With reference to the particular era selected, the period of imperial Rome at the close of the first century, the author observes that it bears, in its whole aspect, a stronger resemblance to the nineteenth century than perhaps any other epoch before the Reformation; and that hardly another period "has ever been equally full of the stirring conflict of purely human interest, and of dramatic contrasts in thought, feeling, and purpose." The numerous allusions to peculiar features of the time are explained in foot-notes.

TRAITS OF REPRESENTATIVE MEN. By GEORGE W. BUNGAY. New York: Fowler & Wells. Pp. 286.

THIS, says the author, is not a book of biography, but of pen and pencil pictures of men of the time who have distinguished themselves in their respective callings, from which the young may derive lessons that will be of service to them. Among the thirty-five men whose biographies are given, with their portraits, politics, literature, the clergy, finance, and art are represented, but science not at all.

---

## PUBLICATIONS RECEIVED.

*** *Authors and others, sending papers and monographs for notice, will please specify, for general information, where they can be procured.*

The Manual Training School of Washington University, St. Louis, 1882–1883. C. M. Woodward, Secretary. Pp. 45.

Admission of Women to Universities. By W. Le Conte Stevens. New York: S. W. Green's Sons. Pp. 26.

The Foundation Principle of Education by the State. By Samuel Barnet. Boston: New England Publishing Company. Pp. 11.

Annual Report of the School Committee of the City of Gloucester, Massachusetts. M. L. Hawley, Superintendent. Pp. 66.

Connecticut Agricultural Experiment Station, Annual Report, 1882. S. W. Johnson, New Haven, Director. Pp. 114.

Zoölogical Society of Cincinnati, Annual Report, 1882. Frank J. Thompson, Superintendent. Pp. 16.

Pitcher Plants. By Joseph H. James. Pp. 11.

The Storage of Electricity. By Henry Greer, New York Agent, College of Electrical Engineering, 122 East Twenty-sixth Street. Pp. 64.

Buffalo Naturalists' Field Club Bulletin; Vol. I, Nos. 1 and 2. Buffalo, New York: George Wardwell. Pp. 48. Bi-monthly. $1 a year.

Nature of Electricity and Cosmic. By Raald Arentz. Hartford, Connecticut: Case, Lockwood & Brainard Co. Pp. 24.

Value of the "Nearctic" as one of the Primary Zoölogical Regions. By Professor Angelo Heilprin. Philadelphia. Pp. 20.

Observations of the Transit of Venus, 1882, at the Lick Observatory, Mount Hamilton. By Professor David P. Todd, of Amherst College. Pp. 8.

State Museum of Natural History, and Completion of the Palæontology of New York. (Legislative Document) Albany. Pp. 28.

Alcohol a Factor of Human Progress. By William Sharpe, M. D. London: David Bogue; New York: G. P. Putnam's Sons. Pp. 14. Sixpence.

Esmarch, Antisepsis, and Bacillus. By William Hunt, M. D. Philadelphia. Pp. 22.

Scrofula and its Gland Diseases. By Frederick Treves, F. R. C. S. Philadelphia: Henry C. Lea's Son & Co. Pp. 77. 10 cents.

The Prevention of Insanity. By Nathan Allen, M. D., Lowell, Massachusetts. Pp. 23.

Vaccination: Its Fallacies and Evils. By Robert A. Gunn, M. D. New York: Nickles Publishing Company. Pp. 38, 25 cents.

From Zone to Zone. A Prize Poem. By Frank D. Y. Carpenter. Pp. 22.

"The Journal of Physiology." Michael Foster, Editor, January, 1883. W. T. Sedgwick, Ph. B., Johns Hopkins University, Baltimore. Pp. 42, with Plate. $5 a year.

The Treatment of Acute Eczema. By George H. Rohé, M. D. Baltimore, Md.: Office of Medical Chronicle. Pp. 7.

What shall we do for the Drunkard? By Orpheus Everts, M. D. Cincinnati, Ohio: Robert Clarke & Co. Pp. 51. Price, 50 cents.

Law Reform and the Future of the Legal Profession. By Charles C. Bonney. Chicago: Legal News Company. Pp. 28.

Sixteenth Annual Report, State Board of Charities, New York. Albany: Weed, Parsons & Co. Pp. 28.

Forest Protection and the Tariff on Lumber. Spirit of the Press. No publisher's name. Pp. 35.

Report on the Development of the Resources of Colorado. By Alden Smith, State Geologist, Denver, Colorado: Chain & Hardy. Pp. 159. 35 cents.

Kissena Nurseries, Flushing, New York, Catalogue of Ornamental Trees and Shrubs. Parsons & Sons Company, limited. Pp. 88.

Forestry Bulletins, Census Office, Nos. 24 and 25. Amount of Tannin in the Bark of some of the Trees of the United States.—Forests of West Virginia.

Archæological Institute of America. Bulletin, January, 1883. Pp. 40: Regulations, Officers, and List of Members. Pp. 14. E. H. Greenleaf, Secretary, Boston, Massachusetts.

Prehistoric Trephining and Cranial Amulets. By Robert Fletcher, United States Army. Washington: Government Printing-Office. Pp. 32, with Plates.

A Study of the Manuscript Troano. By Cyrus Thomas, Ph. D.; Introduction by D. G. Brinton, M. D. Washington: Government Printing-Office. Pp. 237.

The Battle of the Moy: or, How Ireland gained her Independence, 1892-1894. Boston: Lee & Shepard. Pp. 74.

Catalogue of Books published by Houghton, Mifflin & Co., Boston and New York. Pp. 80.

The New-Englanders: A Comedy of the Revolution. By E. M. Davidson. New York: Collins & Brother. Pp. 55. For private circulation.

A Handbook of Vertebrate Dissection. By H. Newell Martin, D. Sc., M. D., M. A., and William A. Moale, M. D. Part II, How to Dissect a Bird. New York: Macmillan & Co. 1883. Pp. 85. 60 cents.

The Unending Genesis. By H. M. Simmons. Chicago: The Colegrove Book Company. 1883. Pp. 111.

Astronomy Corrected. By H. B. Philbrook. New York: John Polhemus. 1882. Pp. 54.

An Outline of Qualitative Analysis for Beginners. By John T. Stoddard, Ph. D., Northampton, Massachusetts. 1883. Pp. 55. 75 cents.

A Dictionary of Electricity. By Henry Greer, New York, Agent of the College of Electrical Engineering, 122 East Twenty-sixth Street. 1883. Pp. 192. $2.

Electro-Magnets. By T. H. Du Moncel. New York: D. Van Nostrand. 1883. Pp. 112. 50 cents.

A Word, Only a Word. By Georg Ebers. New York: William S. Gottsberger. 1883. Pp. 348.

A New Theory of the Origin of Species. By Benjamin G. Ferris. New York: Fowler & Wells. 1883. Pp. 278. $1.50.

Report upon the Triangulation of the United States Lake Survey. By Lieutenant-Colonel C. D. Comstock. Washington: Government Printing-Office. 1882. Pp. 922, with 30 Plates.

The Theories of Darwin and their Relation to Philosophy, Religion, and Morality. By Rudolf Schmid, with an Introduction by the Duke of Argyll. Chicago: Jansen, McClurg & Co. 1883. Pp. 410. $2.

Notes on Evolution and Christianity. By J. T. Yorke. New York: Henry Holt & Co. 1883. $1.50.

Astronomical paper prepared for the Use of the American Ephemeris and Nautical Almanac under the Direction of Simon Newcomb, Ph. D., LL. D. Vol. I. Washington: Bureau of Navigation. 1882. Pp. 487.

---

# POPULAR MISCELLANY.

**Aberrations in Fog-Signals.**—Mr. Arnold B. Johnson, of the Light-house Board of the United States, has been pursuing on our coast parallel investigations with those reported some years ago by Professor Tyndall on the aberrations of audibility of fog-signals. The results of this work, as summarized by Lieutenant-Commander F. E. Chadwick, U. S. Navy, who aided in the investigation, are, that navigators, when attempting to pick up a fog-signal, must give attention to the direction of the wind. If they are to the windward of the signal, in a moderate breeze, the chances are very largely against their hearing it, for there is nearly always a sector, of about 120° to windward of the signal, in which it either can not be heard at all, or is very faintly heard. As they bring the signal to bear at right angles with the wind, the sound will almost certainly in the case of a light wind increase, and will soon assume its normal volume, being heard almost without fail in the leeward semicircle. Fog appears not to be a factor of any consequence whatever in the question of sound. Signals may be heard at great distances through the densest fogs, which may be totally inaudible in the same directions and at the same distances in the clearest atmosphere. It seems established by numerous observations that the best possible circumstances for hearing a fog-signal are in a northeast snow-storm, and they appear to be best heard then with the observer to windward of the signal. In light winds the signal is best heard down the wind or at right angles with the wind. The worst conditions for hearing sound seem to be found in the atmosphere of a clear, frosty morning on which a warm sun has risen and has been shining for two or three hours. The result of the whole is, that "the mariner will do

well, when he does not get the expected sound of a fog-signal, to assume that he may not hear a warning that is faithfully given, and then to heave his lead, and resort to the other means used by the careful navigator to make sure of his position." (Washington: Judd & Detweiler, printers.)

**Herbert Spencer and the Land Question.**—Mr. Herbert Spencer sends to the "St. James's Gazette" (London) the following communication, explanatory of his views on the ownership of land: "During my absence in America, there appeared in the 'St. James's Gazette' (27th of October, 1882) an article entitled 'Mr. Herbert Spencer's Political Theories.' Though, when it was pointed out to me after my return, I felt prompted to say something in explanation of my views, I should probably have let the matter pass had I not found that elsewhere such serious misapprehensions of them are being diffused that rectification seems imperative. Before commenting on the statements of your contributor, I must devote a paragraph to certain more recent statements which have far less justification. In old days among the Persians, the subordination of subject to ruler was so extreme that, even when punished, the subject thanked the ruler for taking notice of him. With like humility I suppose that now, when after I have been publishing books for a third of a century 'the leading critical organ' has recognized my existence, I ought to feel thankful, even though the recognition draws forth nothing save blame. But such elation as I might otherwise be expected to feel is checked by two facts. One is that the 'Edinburgh Review' has not itself discovered me, but has had its attention drawn to me by quotations in the work of Mr. Henry George—a work which I closed after a few minutes on finding how visionary were its ideas. The other is that, though there has been thus made known to the reviewer of a book of mine published thirty-two years ago, which I have withdrawn from circulation in England, and of which I have interdicted translations, he is apparently unconscious that I have written other books, sundry of them political; and especially he seems not to know that the last of them, 'Political Institutions,' contains passages concerning the question he discusses. Writers in critical journals which have reputations to lose usually seek out the latest version of an author's views; and the more conscientious among them take the trouble to ascertain whether the constructions they put on detached passages are warranted or not by other passages. Had the Edinburgh reviewer read even the next chapter to the one from which he quotes, he would have seen that, so far from attacking the right of private property, as he represents, my aim is to put that right upon an unquestionable basis, the basis alleged by Locke being unsatisfactory. He would have further seen that, so far from giving any countenance to communistic doctrines, I have devoted four sections of that chapter to the refutation of them. Had he dipped into the latter part of the work, or had he consulted the more recently published 'Study of Sociology' and 'Political Institutions,' he would not have recklessly coupled me with Mr. George as upholding 'the doctrines of communism, fatal alike to the welfare of society and to the moral character of man'; for he would have discovered the fact (familiar to many, though unknown to him) that much current legislation is regarded by me as communistic, and is for this reason condemned as socially injurious and individually degrading. The writer of the article in the 'St. James's Gazette' does not represent the facts correctly when he says that the view concerning ownership of land in 'Social Statics' is again expounded in 'Political Institutions'—'not so fully, but with as much confidence as ever.' In this last work I have said that, 'though industrialism has thus far tended to individualize possession of land, while individualizing all other possession, *it may be doubted* whether the final stage is at present reached.' Further on I have said that 'at a stage still more advanced, *it may be* that private ownership of land will disappear'; and that '*it seems possible* that the primitive ownership of land by the community . . . will be revived.' And yet again I have said that '*perhaps* the right of the community to the land, thus tacitly asserted, will, in time to come, be overtly asserted.' Now it seems to me that the words I have italicized imply no great 'confidence.' Contrariwise, I think they

show quite clearly that the opinion conveyed is a tentative one. The fact is, that I have here expressed myself in a way much more qualified than is usual with me; because I do not see how certain tendencies, which are apparently conflicting, will eventually work out. The purely ethical view of the matter does not obviously harmonize with the political and the politico-economical views; some of the apparent incongruities being of the kind indicated by your contributor. This is not the place to repeat my reasons for thinking that the present system will not be the ultimate system. Nor do I propose to consider the obstacles, doubtless great, which stand in the way of change. All which I wish here to point out is that my opinion is by no means a positive one; and, further, that I regard the question as one to be dealt with in the future rather than at present. These two things the quotations I have given above prove conclusively."

**Value of the Evidence of Stone Implements.**—Professor Putnam suggests in his report, as curator of the Peabody Museum of Archæology, that it will not do to draw too large inferences from the finding of stone implements. That our recent Indians, he says, "used many exceedingly rude stone implements can not be questioned, and even to-day, among the Western tribes, stones picked up at random are used for various domestic purposes, and when a camp is changed many such are left, with other things which are of too little value to be taken away. From these facts it is evident that the ruder implements and utilized natural forms are not a certain evidence of the period of development of the people who made use of them. That we, in camping out, are so often forced to make use of stones, shells, bones, and withes of roots or bark, should be considered in drawing deductions from the rude character of any set of implements."

**Responsibility of Criminal Lunatics.**—Dr. S. S. Herrick, of the Louisiana State Board of Health, has published (New Orleans) a plea in favor of enforcing the responsibility of criminal lunatics, to the extent at least of putting them where they can do no harm. He starts with the obvious proposition that "the welfare of the sane members of society is vastly more important than the liberty, or even the life, of a dangerous lunatic," and expresses the belief that probably at least three sane persons are acquitted on the "insanity plea" for every insane criminal convicted. A vast amount of silly sentimentality, he continues, "is effused on criminals, both sane and insane; as if a few such worthless wretches deserve more consideration than the great mass of well-behaved and respectable people. It is indeed shocking to take the life of a madman, judicially or otherwise; but it is simply bad management to allow a lunatic to commit an act for which a sane person would be punished, and still worse to risk its repetition." Dr. Herrick objects to capital punishment for any class of criminals; but he advises that the insane be held amenable to punishment like other criminals, and be made to know that its infliction is sure. This will operate as a restraint upon them, and conduce to security of life and property and to the welfare of the insane. It may be alleged, adds Dr. Herrick, "that the restoration of penalties upon the insane is a relapse toward the barbarism of the past. The answer to this is, that by their immunity from punishment is demonstrated a deviation from progress, inasmuch as it practically increases crime and provokes violent and unlawful retaliation."

**What is Adulteration.**—What is the wrong of adulteration if the adulterant is not injurious is shown up by Professor Albert B. Prescott, of Ann Arbor, in one of the papers of the Michigan State Board of Health. Adulteration infringes upon the right of every person—unrestricted except by considerations of sanitary welfare and public police—to decide for himself what he shall eat. "An adulteration is a fraud, a deception, a counterfeit. It is systematically concealed from the purchaser. Its object is to induce people to accept an article which they would not accept for the use then wanted, if it were not for the deceit. To sell an admixture of coffee and chicory, if the terms and proportions of the mixture are printed on the wrapper in a way to have them seen by the purchaser is not adulteration. To sell oleomargarine under its own distinctive name, with no credit bor-

rowed from butter, is not an adulteration. But to supply sugar made from corn-starch for the ordinary sugar made from cane-juice, or to deal out milk-and-water or skim-milk for entire milk, is an adulteration—a violation of the right of the consumer to obtain his food on his own discretion." The plea that may be made, that the adulterant is as wholesome as the real article "is not to be heard at all; it belongs to the consumer to judge for himself what he will provide for his own table." Even if the falsification be not committed to injure health, it is directly objectionable on sanitary grounds, for it is a violation of a great safeguard of health. To the plea that people are not really deceived by the sophistications, but that they are understood, tolerated, and even preferred by customers, "let it be replied, if the pretense is so thin as to deceive no one, and if the admixture is in demand for use as it is, the pretense can the more easily be dropped, and at any rate the admixture must go under its own description and by its own name. Not a single article, unless indictable as a positive poison, need be withdrawn from the market."

**Festivals of the Pagan Iroquois.**—Mrs. Erminie A. Smith gave an interesting account, at the late meeting of the American Association, of some peculiar festivals and superstitions of the Iroquois Indians. About half the Iroquois, she said, are not Christians, but worship a Great Spirit, a god of love, and look to him with great confidence. Their religion is not idolatrous, but quite spiritual. Their only private worship is burning tobacco, and an occasional solitary dance of the squaws. There are eight annual festivals, at which varied Romish, Jewish, or Protestant forms have been engrafted on the ancient dancing, games, and incense-burning. The Tuscaroras of Western New York have hardly a trace of their old religion. About half the Senecas are still pagan. The Onondagas have numerous festivals, beginning with the feast at the first new moon of the new year, at which the chiefs occupy four days in narrating the teachings of Handsome Lake, who nearly a hundred years ago introduced a new form into their religion. On the next three days the chiefs and their followers "put their sins in the wampum" (i. e., confess). The clans are then divided into sides for the gambling, which lasts three days. A white dog is strangled and presented to the winning side, who decorate it and dance around it. Afterward the dog is thrown into the fire, and the sides are reunited. Then there are war-dances, and the women dance without lifting their feet from the ground. At the tapping of the maple-trees there is a war-dance to bring warm weather and make the sap flow. A seven days' festival is held at corn-planting, and there are also strawberry, bean, and green-corn festivals; the latter is preceded by a hunt. In the gambling the women sometimes play against the men for the silver brooches which cover their dresses. The last public festival is at the corn-gathering, when there is a repetition of the confession of sins. A special dance takes place at the death of a medicine-man. The property of an ordinary dead person is often played for. Friendships are cemented by dances. It is a sad fact that the pagan Iroquois are better than their Christian brethren. No wonder the missionaries have great obstacles, when all the immoral white intruders are counted as Christians. New York has much to answer for, and should care more for her Indians than for the Greenlanders and Hottentots. The author dwelt on the great influence for good of one good woman. Great results have flowed from some schools founded long ago. Mrs. Smith introduced the following names of the moons, or months, in the Mohawk tongue: January, old beech-leaves fall; February, bull-frog on pond; March, moss all falls; April, turkeys gobble; May, plant corn; June, strawberries begin; July, corn getting ripe; August, corn quite ripe; September, all ripe and dry; October, getting cold; November, colder; December, very cold.

**Suicide in Switzerland.**—Mr. Wynell-Mayow has attributed the high rate of suicide that has been remarked in Switzerland to Calvinism, and assumes that that republic "is the most Calvinistic country in the world." Mr. William Westall, in the London "Spectator," shows that he is wrong in two points. Calvinism is not the faith of the majority in the confederation,

but only of a part of three fifths of the population, among whom Protestants of every denomination are included, and it has long ceased to be a living faith there. It would be more reasonable to ascribe the prevalence of self-murder to drink, for Switzerland is one of the most drunken countries in the world. The fact is, however, that suicide is not excessively prevalent among the Swiss. Self-murders are committed in the country, but not by natives. Thus the statistics show that, of 263 suicides committed in the Canton of Geneva between 1873 and 1878, 48·3 per cent were committed by foreigners, and only 26·6 per cent by natives of the canton, the others having been natives of other cantons than Geneva.

**Folk-Lore of the Elder and the Juniper.**—The elder and the juniper were formerly sacred to the German goddess Bercht Holda, and many traces of their former sanctity remain in popular customs. Thus elder-branches are scattered around, and juniper is smoked, on the day of *Corpus Christi*. The German name of the juniper (*Wachholder*) appears to be a corruption of a combination of words, which, when analyzed, are found to signify the living tree of Holda. A number of superstitions may be traced back to the former connection of the elder-bush with the goddess. Witches are thought to produce bad weather by stirring water with branches of elder. Some believe that to burn elder-wood will bring harm to the house. It is not considered lucky to cut down elder-bushes or juniper-trees without asking their consent, and offering an exchange. February was the month of Holda, and Lady-Day was her particular day. On that day, the women were accustomed to dance in the sunshine, having elder sticks in their hands, with which they struck the men who came near them. The ancient Prussians made offerings to the god of death under elder-trees, and the pollen was considered dangerous. The Slovaks made elder-men out of the pith, to be servants of the death-god; and the Poles never ventured to cut down the bush except under the protection of an incantation. When any one died in Hildesheim, the undertaker took the measure for his coffin in silence with an elder-rod, and the driver of the hearse had a whip of elder-wood. The gods of the lower world were propitious to every one who planted an elder. In Vinchgau, in the Tyrol, it was thought that any one on whose grave a transplanted elder-bush became green was happy; the bier of the dead was a cross made entirely of elder-wood. The wood was worn as a charm for protection against epilepsy, and whoever took hold of the amulet acquired the disease. Similar superstitions were attached to the juniper. The berries were holy; the plant, bearing green berries along with ripe ones, gave protection against the small-pox, as well as against witches. The pollen was considered invaluable for the young growth of the wood. The spirits loved to dwell among the bushes; whoever could make himself invisible could change himself into a juniper-bush, which no one would dare to touch. A statue of the Virgin was surrounded by juniper, and the Christ-child had a queen-bee in his hand. The dead were burned with juniper-wood. The hornbeam had such an affection for the juniper that it would die if its neighbor was plucked up. The linden, the hypericum, the hazel, the service-tree, and the ash, were also consecrated to Holda, and the first tree in the list played a prominent part as a magic tree, with which many different usages are associated.

**Advantages of Cremation.**—Dr. W. H. Curtis, of Chicago, in an address before the American Public Health Association, at its Savannah meeting in 1881,* summarizes the objections to the disposition of the dead by burial as consisting in the pollution of the soil, air, and water—a real danger in crowded cemeteries; the peril from body-snatchers; and the possible danger of persons being buried alive. The objection to cremation, that it is a heathen rite and not a Christian one, is dismissed as untenable; it may be as Christian as any other method. There remain but two objections that deserve notice. Cremation may be used to destroy evidences of crime; and it is too costly for general use. The former objection is outweighed by the advantages that might be derived from the general adoption of cremation, and can be obviated by the

* Riverside Press, Cambridge, Massachusetts.

enforcement of easy precautions. The cost is reducible to a very small amount by means of the modern appliances. "In the improved furnaces of to-day the body does not come in contact with the fire at all, only with an intense heat of 2000° or more. At this temperature the body simply withers away into a pure white ash. The gases generated are burned in a separated chamber adapted to the purpose, and no smoke, odor, or other unpleasant phenomena occur, to offend the sensibilities of any one, be they ever so acute. To attain these nearly perfect results, of course, costs money. The furnace can not be erected in this country for less than from three to five thousand dollars —a mere *bagatelle* compared with the cost of some of our cemeteries. The fuel necessary to attain this high temperature, with the necessary attendance, makes the expenses of the incineration of a single body about fifteen dollars. The apparatus used by the Danish society at Copenhagen effects the cremation in about an hour, and costs only from five to seven shillings. After all, the costliness of cremation does not seem to be such a very great objection. Of course, if we are forced to send the body to Washington, Pennsylvania, to Milan, to Padua, or any other of the existing crematorics, the privilege is placed beyond the means of any but the rich. But when the crematories are more numerous and accessible, as they no doubt soon will be, the necessity for an expensive lot in an expensive cemetery, an expensive casket, and all the pride, pomp, and circumstance of a funeral *à la mode*, may be dispensed with."

**Instruction in Physics.**—The quality and best methods of education in physics may be stated as the subject of the address of Vice-President Mendenhall before Section B of the American Association at its recent Montreal meeting.* Presupposing that the diffusion of information, or instruction, is an important means of advancing science worthy of a place by the side of original research, and that teaching should be accompanied—not taking the place of it or surrendering itself to it—by experimental work, he suggests that quantitative work, and that the best possible under the circumstances, should occupy the attention of the student, while illustrative experiments and the qualitative work necessary to a good understanding of the subject should be relegated to the lecture-table of the instructor. That which the pupil gets which is of most worth in his course in a physical laboratory is not a familiarity with the principles of the science, but a training in the methods of investigation in use among physicists, including a knowledge of the use and abuse of experiment and the necessary limits of our knowledge derived therefrom. The study which he ought to make of errors, instrumental and accidental, will be of great value in various fields. It is better for the laboratory to contain a few instruments of precision than a large number of inferior performance and accuracy. It is not a matter of great importance upon what particular department of physics a student shall spend his time and strength. The underlying principles of the method are common to all, and skill in one begets facility in the others. To sum up, the course of study in physics for the undergraduate collegian should include a sufficient training in mathematics to enable him to apply his knowledge with ease and facility to the more common physical problems; a thorough and exacting course of text-book and lecture-work, in which the application of his mathematical knowledge would be made, and during which all illustrative experiments necessary to a complete understanding of the text should be exhibited by the instructor from the lecture-table; and, finally, this to be supplemented by a course in the laboratory in which more attention is paid to the quality than to the quantity of work done; during which every problem is discussed, as far as possible, both mathematically and experimentally, and especial attention is given to the discussion of the results of experiment and of the more elementary portions of the theory of errors. "Considering the work as thus divided into three parts," says Professor Mendenhall, "I am unable to see which is the least essential."

**Work for Amateur Astronomers.**—Professor Edward C. Pickering, of the Harvard College Observatory, invites amateurs who have small telescopes to the observation of the variable stars, and assures them that by

* Printed at the Salem Press, Salem, Massachusetts.

systematizing their work, and each selecting a particular field, they can not only observe with more satisfaction to themselves, but may aid the progress of science. Some may make real discoveries, and they are promised all the credit they may deserve for them, if they give due early notice of the fact. Steady and repeated observations of the same object are wanted once or twice in every month, in order to secure determinations of their light-curves or variations. This point has been heretofore to a large extent omitted, and only the fact of variation, its period, and its extremes, have as a rule been ascertained. Amateurs may do service in this line, while professional observers are attending to more delicate points. Professor Pickering has published a pamphlet giving directions and the other information needed to secure intelligent observations, which may be had on application to him at Harvard College Observatory, Cambridge, Massachusetts.

**Roman Remains.**—Mr. Alfred Tylor has recently described, before the Royal Institution of Great Britain, some Roman remains that were discovered last year in London about nineteen feet below the present surface of the ground. They include several cinerary urns, one of which, fifteen inches high, was of glass, containing the results of the cremation of human bodies, and a remarkable turned vase of stone. Four of the urns were inclosed in leaden *ossuaria* without solder, in the inside of one of which was found an emblem of Mithra, the Persian sun-god. Some of the other urns were protected by roofing-tiles. The coins found during the excavations bore dates from A. D. 60 to 300. The Mithraic emblem was probably of a date soon after A. D. 50.

**Dizziness and Deafness.**—Dr. William James, of Harvard University, has made some experiments to test the modern theory that the semicircular canals, instead of being connected with the sense of hearing, serve to convey the feeling of movement of the head through space, which, when intensified, becomes dizziness. It occurred to him that deaf-mutes, having their auricular organs injured, might afford some corroboration of the theory, if it were true, by showing a smaller susceptibility to dizziness than persons with normal hearing. Of 519 deaf-mutes examined by subjecting them to a rapid whirling, 186 were wholly insusceptible of being made dizzy, 134 were made dizzy in a very slight degree, and 199 were normally, and in a few cases abnormally, sensitive. Nearly 200 students and instructors in Harvard College, supposed to have normal hearing, were examined for purposes of comparison, and but a single one proved exempt from the vertigo. These results seemed to Dr. James to support the theory which was the object of his inquiry. It occurred to him that those persons not affected by dizziness ought also to lose their power of orientation when diving under water; but the experiments that were made to test the correctness of this view were so varied in their results that no conclusions could be drawn from them.

**Errata.**—*Messrs. Editors:* Permit me to call attention to a few errors in the first column of page 714 that make nonsense of what I am quoted as saying of the supposed "lignified snake." According to my remarks, as published in the Washington "Star," in line two, "rudimentary" should read "rejectamentary." In line twenty-seven, "larva" should read "liber." In lines thirty-three, thirty-four, "without interference with the growth or soundness of the tree" should read "except where the bark is already loosened, a supposition which involves the idea of death or decay in the tree, and consequent incapacity to renew tissue. C. V. RILEY."

---

## NOTES.

IN the twenty-third "Forestry Bulletin" of the Census-Office, the total consumption of wood for fuel in the United States during the year of the census is estimated at 145,778,137 cords, the value of which was $321,962,373. Of this quantity, 140,537,490 cords were used for domestic purposes; 1,971,813 cords by railroads; 787,862 cords by steamboats; 358,074 cords in mining and amalgamating the precious metals; 266,771 cords in other mining operations; 1,157,522 cords in the manufacture of brick and tile; 540,448 cords in the manufacture of salt; and 158,208 cords in the manufacture of wool. During the same year 74,008,972 bushels of charcoal were burned, the value of which was $5,276,736.

THAT plants have the faculty of adapting themselves to suit a new environment has been curiously illustrated in the case of some Australian acacias that were introduced to the Neilgherries of India in 1845. At home, these trees flower in October, which is there a spring month. The transplanted acacias continued in India to flower in October till about 1860, when they were observed to flower in September; in 1870 they flowered in August; in 1878 they flowered in July; and lastly, in 1882, they began to flower in June, the spring month which corresponds most nearly with the Australian October. The trees imported since 1845 have not yet gone so far back in the time of their flowering.

A FEMALE hippopotamus, which was presented to the London Zoölogical Society in 1853, by the Viceroy of Egypt, has just died, with the exhibition of all the signs of old age. Her mate died in 1877, after having lived twenty-seven years in the garden. As the condition of the teeth and bones indicate that the animals could hardly have been able to live as long in their native wilds as they did under attention at the park, the conclusion is drawn that the limit of life of the hippopotamus is about thirty years.

DR. JOSEPH KIDD relates, in "The Practitioner," a history of the course of disease in a family, the effect of which is to illustrate strikingly, if it does not demonstrate, the transmissibility of Bright's disease. A woman, two of whose brothers had died of this disease in early manhood, who herself died of it when sixty years of age, was the mother of twelve children, seven of whom also died from it, and grandchildren, of whom two at least are afflicted with kidney-disease.

A STORY is told of a woman in Boston who discovered and located a leak in the waste-pipe of a wash-bowl, by taking advantage of the fondness of cats for the oil of valerian. Having put two cats in the parlor, where an offensive odor was perceived, the woman poured the oil into the basin of an upper room and watched for the result. The cats shortly began to sniff the air and move toward a closet through which the waste-pipe ran, then jumped upon a shelf and purred as if enjoying a great luxury. The wall was cut away to expose the pipe, and a considerable leak was found at the very spot pointed out by the cats.

THE Russian admiral, Count Frederic B. Lütke, known as the "Patriarch of the Fleet," a distinguished navigator of more than half a century ago, has recently died. He circumnavigated the globe in 1817–'18; was employed during the four successive summers, 1821–'24, in scientific surveys of Nova Zembla, from which rich additions to the knowledge of the Arctic regions were derived; and from 1826 to 1829 he commanded an expedition of the corvettes Seniavine and Moller to Kamchatka and other parts of Northeastern Asia, Behring's Sea and its archipelagoes, and Alaska, in the course of which extensive collections were made and much knowledge was acquired.

PROFESSOR JOHN NICHOL, speaking in his "Historical Sketch" of American literature of the non-existence of international copyright, says that "this gross injustice to the authors on both sides of the Atlantic, for the benefit of the publishers on one, leads to the intellectual market being glutted with stolen goods. Considerations of interest in business are of course everything; those of principle or art or patriotism nothing."

ENGLAND has lost an active and highly appreciated scientific student by the death of Edward B. Tawney, Assistant Curator of the Woodwardian Museum, Cambridge. He was the son of a clergyman, and was born in 1841. For six years before going to the Cambridge Museum, he had been Assistant Curator of the Bristol Museum. He was author of numerous papers on topics in geology, was versed in several Continental languages, and relished the masterpieces of literature; thus showing in his life that science is not narrow or its pursuit humdrum.

THE United States Commission of Fish and Fisheries is about to build, in connection with its new station there, an aquarium, to be devoted to biological researches of every description, at Wood's Hole, Massachusetts. Preparations are being made at the adjoining station for the artificial propagation of cod, mackerel, halibut, and other fishes useful for food.

THE death is announced of Johann Benedict Listing, a German philosopher who was distinguished for his studies in recondite questions in physics—in such matters as the world ordinarily does not, or does not try to, understand. His most important discovery was a law, called after him, Listing's law, in physiological optics, which relates to the position of the eyeball when it turns from looking at one object to another, without movement of the head. Other studies related to the geometrical qualities of knots, the inversion and perversion of geometrical figures, helices, the complexes of space, and similar puzzling conceptions.

DR. CARL HORNSTEIN, Professor and Director of the observatory at the Carl Ferdinand University, Prague, died December 22d, aged fifty-eight years.

# INDEX.


PAGE

Abbott, Charles C., M. D. ... 315
Abney, Captain, F. R. S. ... 397
Aborigines of the Isthmus ... 427
Adulteration? What is ... 859
African, The, in the United States ... 433
African, The, in the United States, Letter on ... 841
Allen, Nathan, M. D., LL. D ... 139
Allen, Professor Grant ... 94, 662
Amos, Sheldon ... 721
Animal Life, Queer Phases of ... 589
Antiquity of Man in America ... 286
Arcadia, A South African ... 650
Asphalts, American and Foreign ... 188
Ass's Milk for Infants ... 425
Astronomers, Amateur, Work for ... 862
Astronomy, Physical. Modern Methods in ... 477

Backboned Family, Progress of ... 739
Bain, Alexander ... 458
Bates, Henry Hobart, M. A. ... 788
Beard, R. O., M. D ... 535
Beets, Wine from ... 287
Benson, Berry ... 120
Bergeron, M. ... 495
Bicycles and Civilization ... 556
Bicycle Controversy, The, in Stockbridge, Letter on ... 550
Birds in Cold Weather ... 431
Boileau, J. P. H., M. D ... 172
Boodle, R. W. ... 511, 606
Books noticed:
"Ideological Etymology" (Andrews) ... 123
"Elements of Universology" (Andrews) ... 123
"Vice Versa" (Anstey) ... 125
"The Coming Democracy" (Harwood) ... 126
"The Change of Life" (Tilt) ... 126
"The Cornell University Register" (1881–'82) ... 126
"Light" (Wright) ... 127
"Memoir of Daniel Macmillan" (Hughes) ... 127
"Progressive Religious and Social Poems" (Vaughan) ... 127
"Water-Power of the Southern Atlantic Water-Shed" (Swain) ... 127
"Studies in Science and Religion" (Wright) ... 128
"Physiognomy" (Stanton) ... 129

Books noticed: PAGE

"Statistics of the Population of the United States" (Walker)..... 129
"Wave-Lengths of Fraunhofer Lines" (Mendenhall)..... 129
"Report on Submarine Mines" (Abbott)..... 129
"Chronological List of Auroras," 1870 to 1879 (Greeley)..... 130
"Statistics of Public Indebtedness" (Porter)..... 130
"Appalachia," June, 1882 ..... 130
"Atlantis" (Donnelly) ..... 131
"Meteorology of Tokio, Japan" (Mendenhall)..... 132
"The Chemistry of Saké-Brewing" (Atkinson) ..... 133
"Construction and Maintenance of Time-Balls" (Hazen)..... 133
"George Ripley" (Frothingham) ..... 276
"The New Botany" (Beal)..... 277
"Is Consumption contagious?" (Clapp)..... 277
"The Sun" (Young) ..... 278
"La Navigation Électrique" (Dary)..... 278
"Report of Smithsonian Institution" (1880)..... 278
"The Peak in Darien" (Cobbe)..... 279
"The Fire-Protection of Mills" (Woodbury)..... 279
"Easy Star Lessons" (Proctor)..... 280
"Report of the Commissioner of Education for 1880"..... 280
"Manual of Blow-pipe Analysis" (Cornwall)..... 281
"Catalogue of 1,098 Stars"..... 282
"James Mill" (Bain)..... 414
"The Winners in Life's Race" (Buckley)..... 415
"Herbert Spencer on the Americans, and the Americans on Herbert Spencer" ..... 416
"Unity Pulpit" (Savage)..... 416
"A Practical Treatise on Hernia" (Warren)..... 417
"Proceedings of the Biological Society of Washington"..... 418
"A Guide to Modern English History" (Cory)..... 419
"Address (New England Manufacturers' and Mechanics' Institute) (Atkinson)..... 419
"Contributions to Mineralogy" (Genth)..... 419
"Age of Tejon Rocks of California" (Heilprin)..... 420
"Proceedings of the Davenport Academy of Natural Sciences"..... 420
"How to succeed" (Abbott) ..... 420
"Cerebral Hyperæmia; Does it exist?" (Buckley)..... 420
"The Solution of the Pyramid Problem" (Ballard)..... 421
"A Guide to Collodio-Etching" (Hartley)..... 421
"United States Commission of Fish and Fisheries" (1879)..... 421
"The Gulf Stream" (Bartlett)..... 422
"Proceedings of the Department of Superintendence of the National Educational Association" (1882)..... 422
"Putnam's Art Hand-Books" (Carter)..... 422
"A Dictionary of Music and Musicians" (Grove)..... 422
"The Hoffman Cover and Binder"..... 423
"American Journal of Physiology"..... 423
"Modern Stenographic Journal"..... 423
"Ragnarok" (Donnelly)..... 560
"Zoölogical Sketches" (Oswald)..... 561
"Check-List of North American Birds" (Coues)..... 563

Books noticed: PAGE
"New Check-List of North American Moths" (Grote) ..... 563
"House-Drainage" (Gerhard) ..... 564
"Diagram for Sewer Calculations" (Gerhard) ..... 564
"New Method of learning the French Language" (Berger) ..... 564
"Chapters on Evolution" (Wilson) ..... 564
"Dress and Care of the Feet" (Kahler) ..... 565
"Report of the Maryland Fish Commissioner" (Ferguson) ..... 565
"Report of the Wisconsin Board of Health" ..... 565
"Youth: Its Care and Culture" (Mortimer-Granville) ..... 565
"Report of the Detroit Board of Health" ..... 566
"American Citizens' Manual" (Ford) ..... 566
"Railroad Economics" (Robinson) ..... 566
"Strength of Wrought-Iron Bridges" (Robinson) ..... 566
"Potable Water" (Folkard) ..... 566
"Ottawa Field Naturalists' Club" ..... 566
"Report of the Ninth Cincinnati Industrial Exhibition" ..... 566
"Practical Life and the Study of Man" (Wilson) ..... 567
"Schelling's Transcendental Idealism" (Watson) ..... 567
"Speech and its Defects" (Potter) ..... 567
"The Magazine of Art" ..... 567
"Revue Scientifique" ..... 568
"Facts and Phases of Animal Life" (Morwood) ..... 704
"Swift" (Stephen) ..... 705
"Herbert Spencer on American Nervousness" (Beard) ..... 706
"History of the Pacific States of North America." *Central America.* (Bancroft) ..... 707
"Anatomy of Birds" (Shufeldt) ..... 708
"American Society of Microscopists ..... 708
"Poems" (Savage) ..... 708
"Work at Harvard Observatory" (Pickering) ..... 709
"Gospel of the Stars" (Seiss) ..... 709
"Education, Moral" (Buchanan) ..... 710
"Report of the Peabody Museum" ..... 710
"Lectures on Art" ..... 711
"The Factors of Civilization" ..... 711
"American Hero-Myths ..... 711
"Wide Awake" ..... 712
"Report on Six Hundred Tornadoes" ..... 712
"The Science of Politics" (Amos) ..... 850
"Description of Houghton Farm" (H. E. A.) ..... 851
"Anatomical Technology" (Wilder and Gage) ..... 853
"Experimental Physiology" (Owen) ..... 853
"Physics, and Occult Qualities" (Taylor) ..... 853
"Barometric Hypsometry" ..... 854
"The Eleventh Commandment" (Barrili) ..... 854
"Signal-Service Tables" (Dunwoody) ..... 854
"A Study of Tennyson's 'The Princess'" (Dawson) ..... 854
"Text-Book of Geology" (Geikie) ..... 855
"Annals of the Astronomical Observatory of Harvard College" ..... 856
"Quintus Claudius" (Eckstein) ..... 856
"Traits of Representative Men" (Bungay) ..... 856

PAGE
Brain-Weight and Brain-Power ..... 172
Briesen, T. von ..... 503
Brooks, Professor W. K. ..... 195, 364
Buckley, Arabella B. ..... 739
Büttner, C. G. ..... 650

Calendar, Origin of the, and Astrology ..... 825
Camp-Meeting, Evolution of the ..... 622
Cell-State, The ..... 174
Cemetery, A Prehistoric ..... 445
Cesspools, The Poison of ..... 718
Child, A. L., M. D. ..... 204
Chittenden, C. E. ..... 842
Citric Acid, Action of, on Minerals ..... 288
Civilization, Bicycles and ..... 556
Civilization, Coeval Grades of ..... 430
Cohn, Professor Ferdinand ..... 174
Cold, The Poles of Extreme ..... 570
Colored Population, Vital Conditions affecting the ..... 714
Comets, M. Respighi on the Light of ..... 574
Comets, Professor Huggins on ..... 428
Comet, The Great, of 1882 ..... 289
Consumption, Infectious ..... 716
Continent, The Sunken Southern, again ..... 429
Copyright Discussion, Letter on ..... 842
Correspondence ..... 120, 550, 841
Cowries and African Currency ..... 141
Craters, Lunar, The Formation of ..... 495
Cremation, Advantages of ..... 861
Criminality in Animals ..... 244
Cults, Ancient, among the Berbers of Morocco ..... 286
Curiosities, Physiognomic ..... 63
Customs, Ancient Old World and American, Analogies of ..... 287

Dawkins, W. Boyd ..... 72
Deafness, Dizziness and ..... 863
Deformities, Bodily, in Girlhood ..... 322
Delbœuf, M. ..... 767
Depression, The, of our Atlantic Coast ..... 136
Donkey, Origin of the ..... 783
Draper, Professor Henry, Sketch of ..... 405
Du Bois-Reymond, Emil ..... 20
Dwarfs and Giants ..... 767

Eatables, A Few Words about ..... 677
Editor's Table ..... 121, 268, 410, 553, 699, 843
Education, Bain on University ..... 559
Education, Brain-Power in ..... 539
Education, Machine ..... 553
Education, Mechanical and Vital ..... 719

PAGE
Education, the Influence of, on Observation ..... 359
Edwards, Henri Milne-, Sketch of..... 545
Egleston, N. H..... 774
Egypt as a Health Resort ..... 141
Elder and the Juniper, Folk-Lore of the..... 861
Engler, E. A. ..... 156, 328
Errata..... 863
Esquimaux, The..... 137

Farming, Scientific, at Rothamsted..... 81, 383
Fingal's Cave, Is it artificial?..... 231
Flora, North American, Succession of ..... 135
Flora, The, of North America..... 283
Florida, Remedial Value of the Climate of..... 641
Foester, Professor William ..... 825
Fog-Signals, Aberrations in..... 857
Foot-prints, Fossil, Human, in Nevada..... 137
Forestry, Scientific, Progress of ..... 140
Forests, The Census and the..... 774
Forests, The World's, Waste of ..... 428
Forest, The Possible Annual Yield of a... ..... 572
Fouillée, M. Alfred..... 300, 521

Geological Map, the Proposed, of Europe..... 283
Giants, Dwarfs and..... 767
Gilliam, Professor E. W..... 433
Girlhood, Bodily Deformities in..... 322
Gold, The Decrease of..... 503
Growth, Annual, of Trees..... 204
Growths, Some Curious Vegetable ..... 30
Gulf Stream, The..... 134

Hall, James, LL. D..... 815
Hallock, E. J., Ph. D..... 188
Hamilton, Frank Hastings, M. D..... 1
Hammond, Dr. W. A..... 760
Héricourt, M. ..... 225
House-Walls, Hygiene in..... 135
Hunt, T. Sterry, F. R. S..... 165

Ice and Fog in the North Atlantic..... 628
Implements, Stone, Value of the Evidence of..... 859
Increase, Human, The Law of ..... 39
Indians of the Hudson Bay Territory..... 424
Indians, The American, and the Aryan Race ..... 286
Infection? Do House-Flies convey..... 571
Insanities, Perceptional..... 760
Iroquois, the Pagan, Festivals of ..... 860
Isthmus, Aborigines of the..... 427

James, Joseph F..... 445
Janssen, Jules C. ..... 477

PAGE
Jaw-Bone, The Infant Giant, of Stramberg ..... 138
Juniper, Folk-Lore of the Elder and the..... 861

Kacheen, Marriage Customs of the..... 578

Lacassagne, A..... 244
Land Question, Herbert Spencer and the..... 858
Lansing, Gerrit L..... 577
Lapham, Increase Allen, Sketch of..... 835
Larrabee, W. H..... 30
Law against Right ..... 699
Ledyard, L. W..... 842
Le Sueur, W. D., B. A..... 145
Letters, Roman, Physiological Analogies of the..... 285
Life, American, Social Forces in..... 491
Life, Animal, Queer Phases of..... 589
Life-Insurance, The Decline of..... 429
Lion, The British..... 72
Literary Notices..... 123, 276, 414, 560, 704, 850
Lockwood, S., Ph. D..... 341
Lunatics, Criminal, Responsibility of..... 859
Lyman, Oliver E..... 803

Magnified Objects, Apparent Size of..... 137
Mallock and his New Science..... 121
Man, Antiquity of, in America..... 286
Marriage Laws, Indian..... 135
Mastodon, A, in an Old Beaver-Meadow..... 341
Matter, Speculations on the Nature of..... 789
Medicine, The Schools of..... 535
Mental Shock and Inebriety..... 717
Miles, Manly, M. D..... 81, 383
Moraine, The Glacial, in Pennsylvania..... 134
Mortality in Town and Country..... 424
Mound-Builders, Were the, Indians?..... 285
Musical Sensations..... 225

Names, Geographical, Central American, Letter on..... 120
Narcotics, Lessons on the Danger of..... 718
Nerve-Vibration as a Remedy..... 575
North Atlantic, Ice and Fog in the..... 628
Notes..... 143, 288, 431, 575, 719, 863

Observatory, Dearborn, Work of the..... 570
Ohm's Law, Experimental Demonstration of..... 713
Oswald, Felix L..... 6, 345, 471, 589, 754
Overwork, The Question of..... 411

Parrish, Dr. Joseph..... 692
Pasteur, A Medal to..... 284
Pathology, A Chapter in Transcendental..... 659
Petroleum, Origin of..... 284

PAGE
Philanthropy, Scientific ..... 300, 521
Photography, Recent Advances in ..... 397
Physics, Instruction in ..... 862
Physiognomic Curiosities ..... 63
Pietrement, C. A. ..... 783
Piratical Publishers ..... 656
Piratical Publishers or a Piratical Government ..... 702
Plants, Use of the Gummy Secretions of ..... 572
Playas and Playa Lakes ..... 380
Politics, Hindrances to the Science of ..... 848
Politics, Nature and Limits of the Science of ..... 721
Popular Miscellany ..... 134, 283, 424, 569, 713, 857
Prairies, Formation of ..... 285
Pre-Indian People, Traces of a ..... 315
Pressure, Atmospheric, Subterranean Effects of ..... 716
Primitive Man? Who was ..... 94
Principle in Small Things ..... 273
Publications Received ..... 133, 282, 423, 568, 712, 856
Publishers, Piratical ..... 656

Radcliffe, Dr. C. B. ..... 677
Radiations, Solar, Langley's Observations on ..... 715
Railway Consolidation, Growth and Effect of ..... 577
Railway Consolidation, Letter on ..... 842
Records, Ancient Maya ..... 718
Recreation, the Gospel of ..... 354
Redding, Benjamin B., Obituary Notice of ..... 575
Religion, Natural ..... 511, 606
Rhine, Alice Hyneman ..... 625
Roberts, Charles, F. R. C. S. ..... 322
Roman Remains ..... 863
Rothamsted, Scientific Farming at ..... 81, 383
Russell, Israel C. ..... 380
Russian Geological Research ..... 287

Schleiden, Matthias Jacob, Sketch of ..... 256
Schools, European Technical ..... 573
Schreiber, Dr. A. ..... 109
Science, Incentives in the Pursuit of ..... 844
Science in Relation to the Arts ..... 48, 206
Science in the Sick-Room ..... 497
Sciences, the Natural, The Relations of ..... 165
Science, The, of the Present Period ..... 20
Scientific Weekly, The New ..... 843
Scott, Leonard ..... 656, 843
Sea-side, Sewage at the ..... 625
Servant-Girls, Legal Status of the ..... 803
Sewer-Gas ..... 1
Shackford, Captain J. W. ..... 628
Shooting-Stars, their Traditions and Origin ..... 142
Sick-Room, Science in the ..... 497

PAGE
Siemens, C. W., F. R. S. . . . . 48, 206
Small Things, Principle in. . . . . 273
Smith, Mr. Goldwin, on the Data of Ethics. . . . . 145
Smyth, C. Piazzi. . . . . 240
Snake, A Lignified. . . . . 139
Snake, Lignified, More about the. . . . . 713
Social Forces in American Life. . . . . 491
Spectroscope, The, and the Weather. . . . . 240
Spencer, Herbert . . . . . 354, 491
Spencer, Herbert, and the Land Question . . . . . 858
Spencer, Herbert, The Banquet to. . . . . 410
Spencer's Impressions of America. . . . . 268
Stanley, H. . . . . 120
Statue, The Bartholdi. . . . . 414
Stature, American. . . . . 571
Stethoscope, Evolution of the. . . . . 488
Storms, Origin of, Letter on. . . . . 120
Suicide in Switzerland. . . . . 860
Sumatra, Life among the Battas of. . . . . 109
Sun, Theory of his Light and Heat, Letter on. . . . . 120
Superstition, Curiosities of. . . . . 345, 471, 754
Survey, Northern Transcontinental. . . . . 715
Survey, The New York Geological. . . . . 815

Thomson, Sir C. Wyville, Sketch of. . . . . 693
Time Keeping in London. . . . . 156, 328
Trees, Annual Growth of. . . . . 204

University Ideal, The. . . . . 458

Varieties, Entertaining. . . . . 263
Venus, Observations of the Recent Transit of. . . . . 569
Vice, The Economic Function of. . . . . 732
Vivisection and Practical Medicine. . . . . 615

Walton, Dr. George E. . . . . 641
Weeks, Clara S. . . . . 497
Wheat, The Pedigree of. . . . . 662
Whitehouse, F. Cope, M. A. . . . . 231
Wilks, Samuel, M. D . . . . . 488
Wine from Beets. . . . . 287
Wurtz, Charles Adolphe, Sketch of. . . . . 114

Yeo, Dr. G. F. . . . . 615
Young, Professor C. A. . . . . 289

Zoölogy, Speculative. . . . . 195, 364

END OF VOL. XXII.